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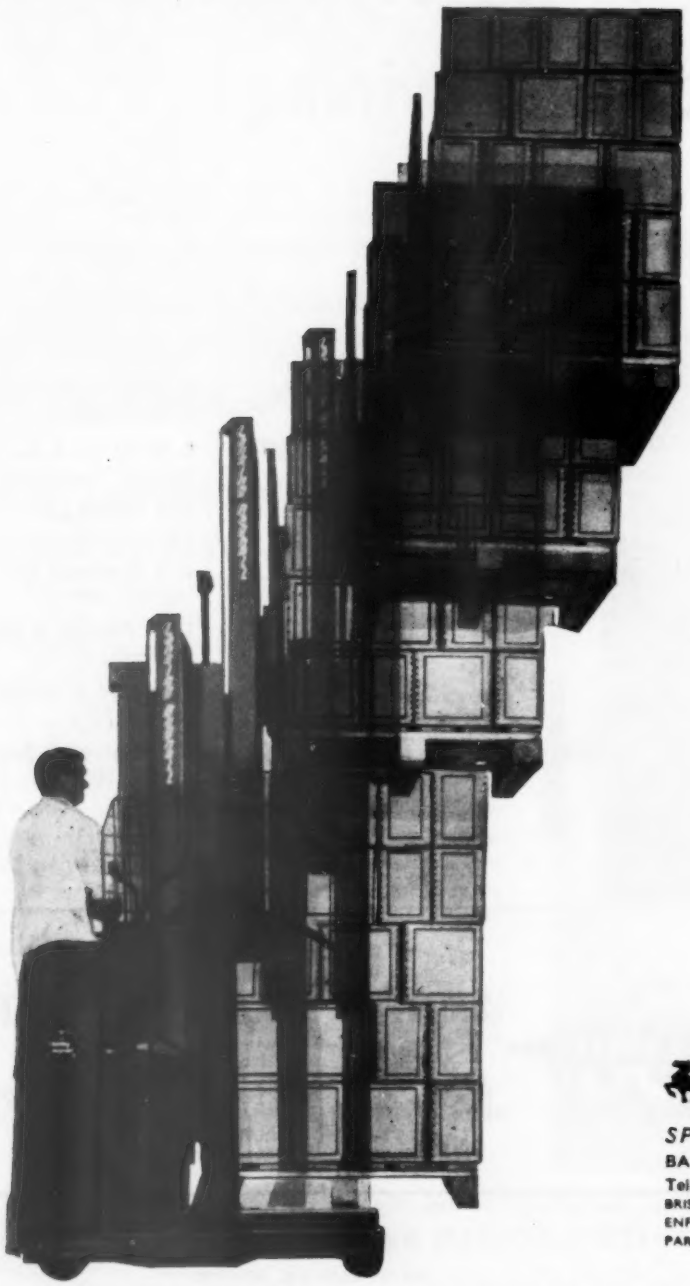

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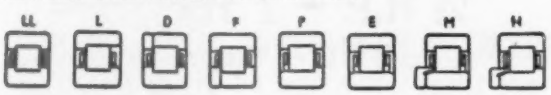

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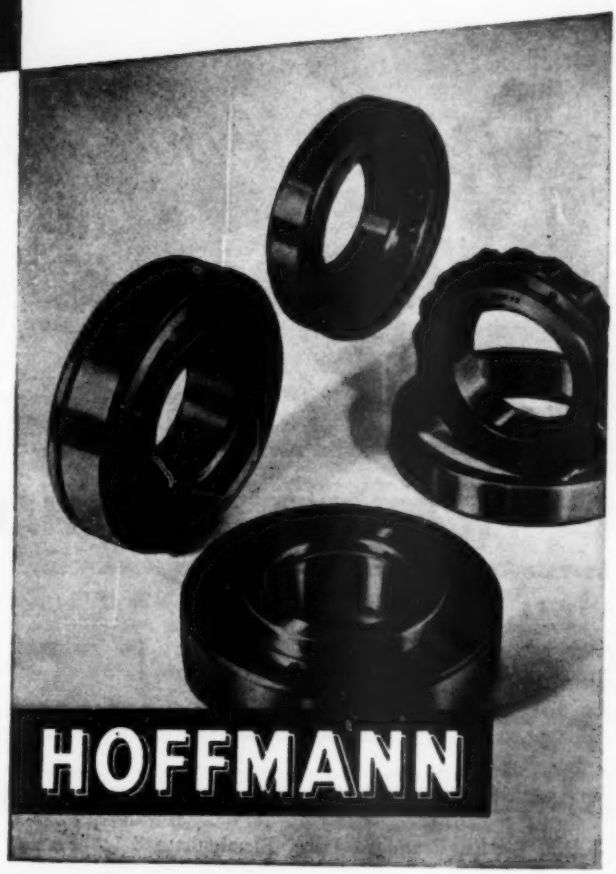

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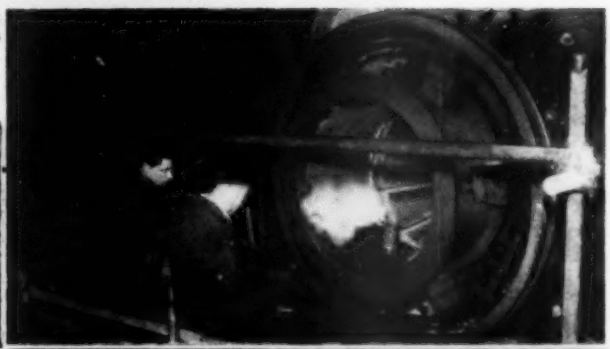

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Top—Operation on a twin diameter (45" & 19½" dia.) extrusion press ram at an aluminium works in England.

Left—Tooling a 17 in. dia. alternator shaft at a hydro electric power station in Malaya.

Right—Honing a 33 in. dia. ball mill trunnion at Billingham.

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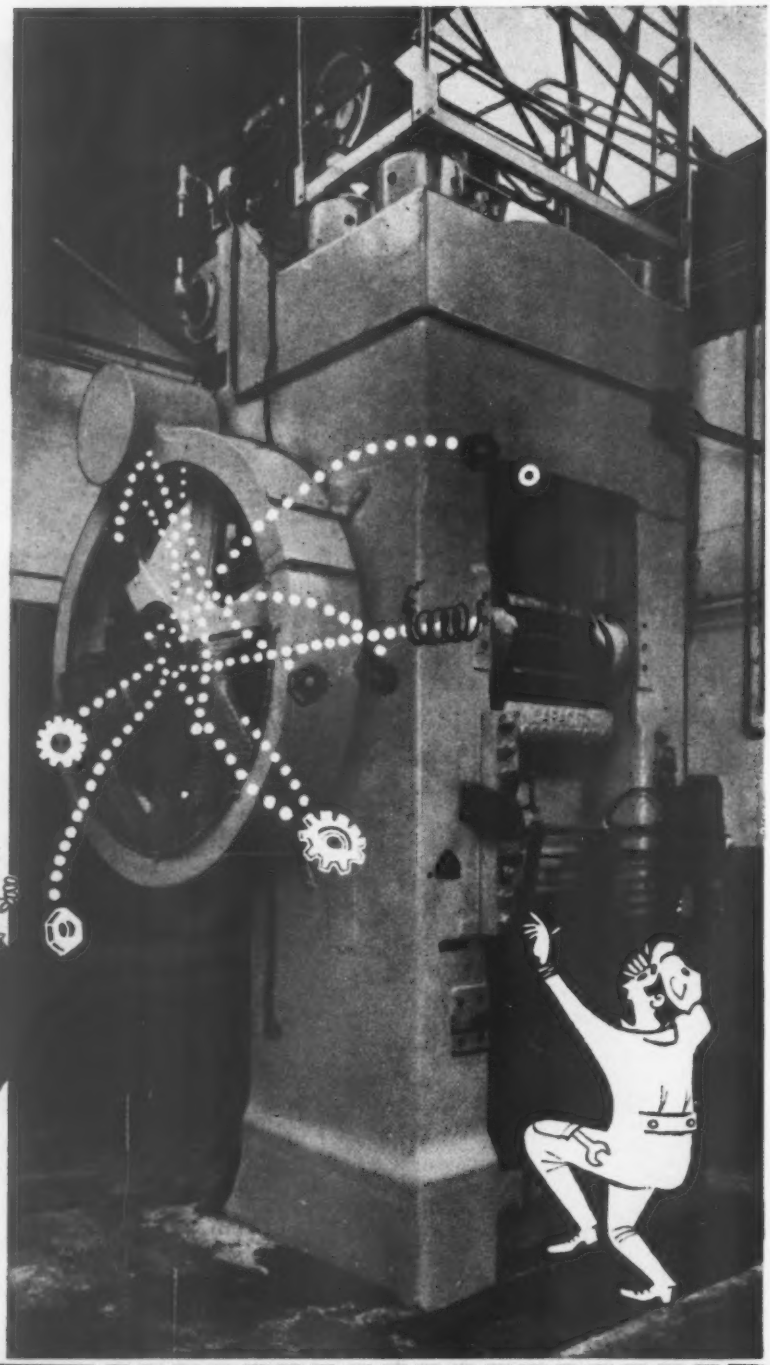

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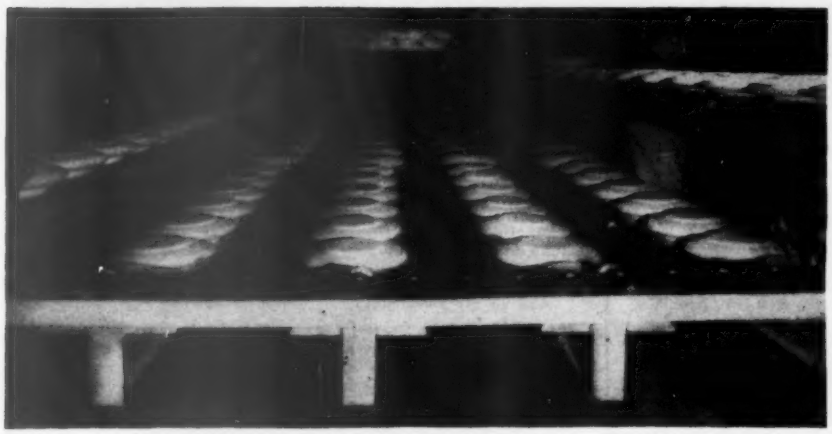

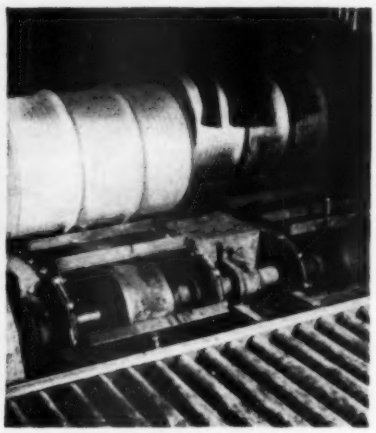

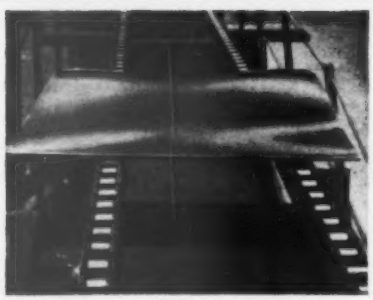

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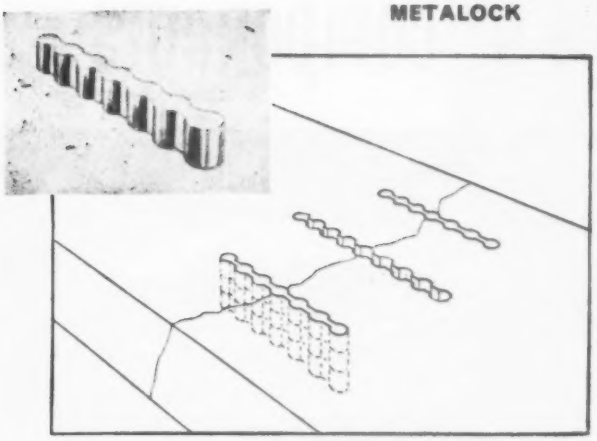

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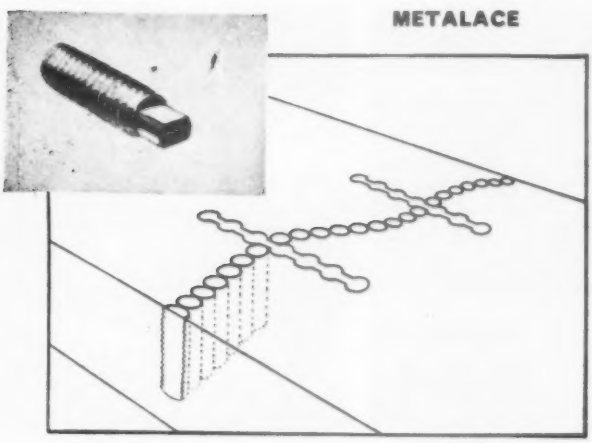

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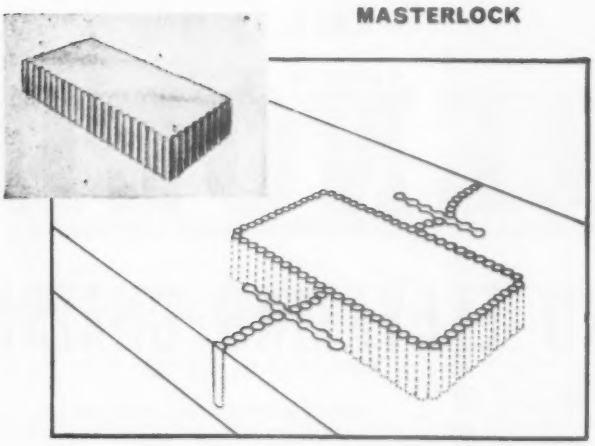

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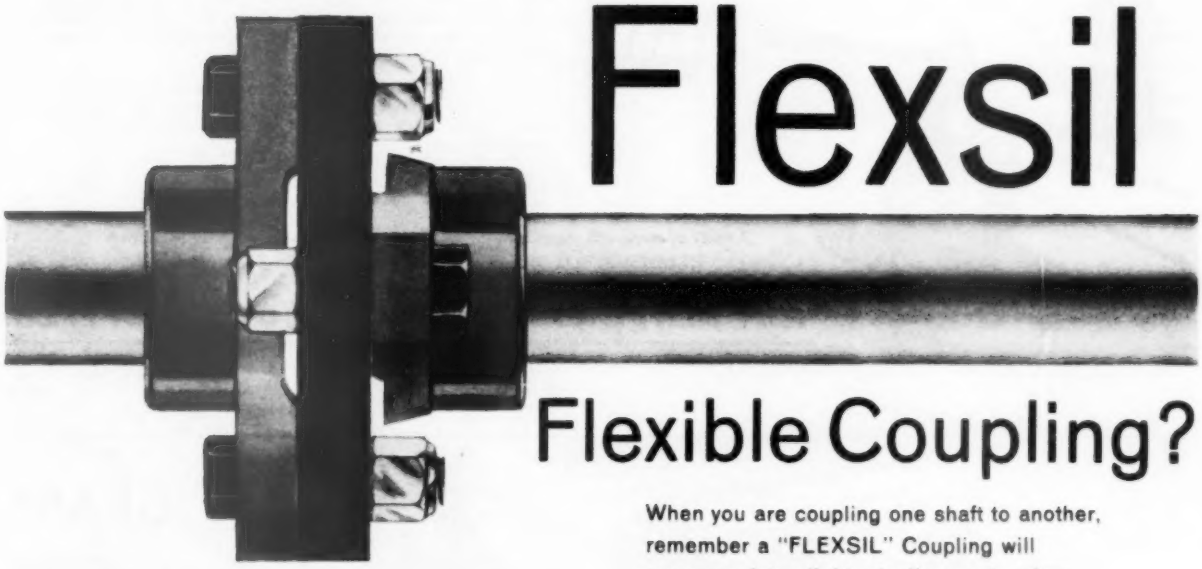

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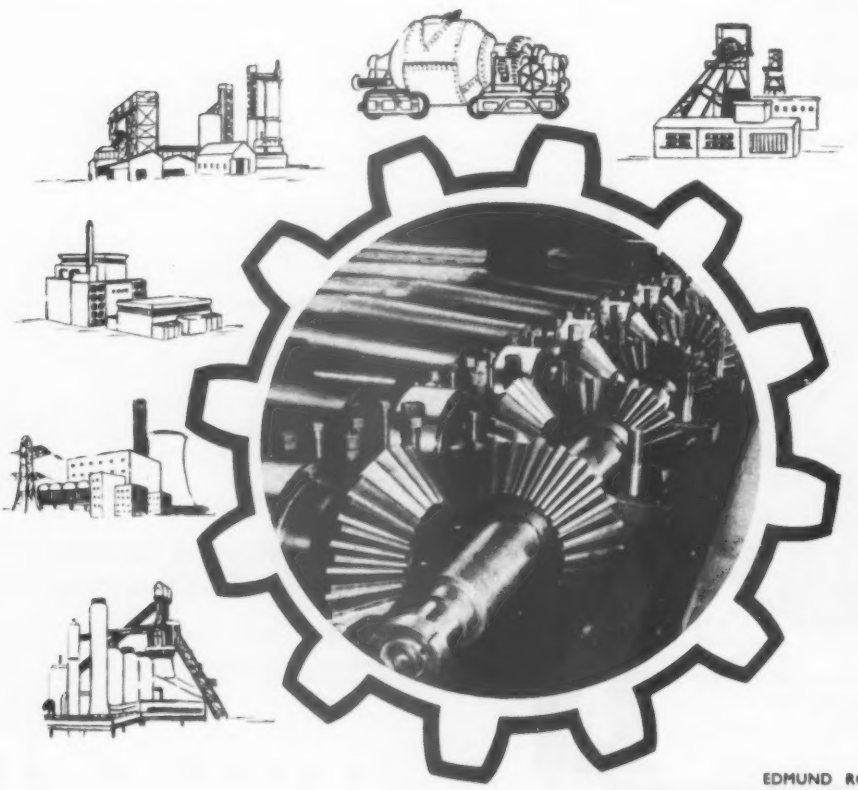

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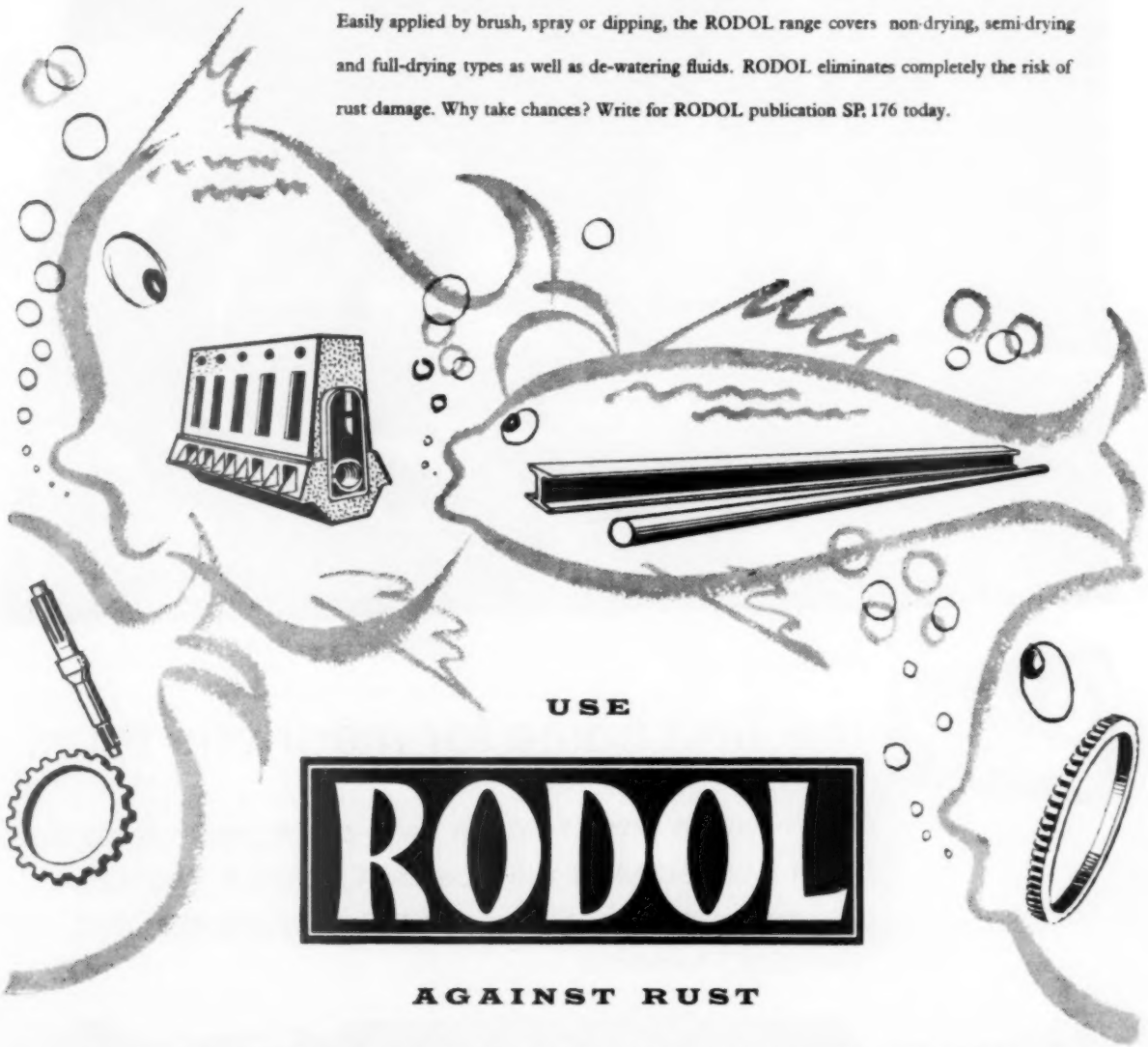

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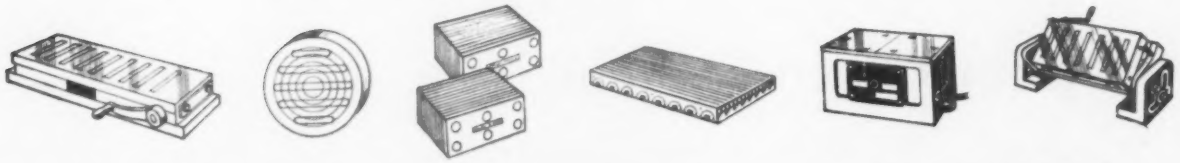

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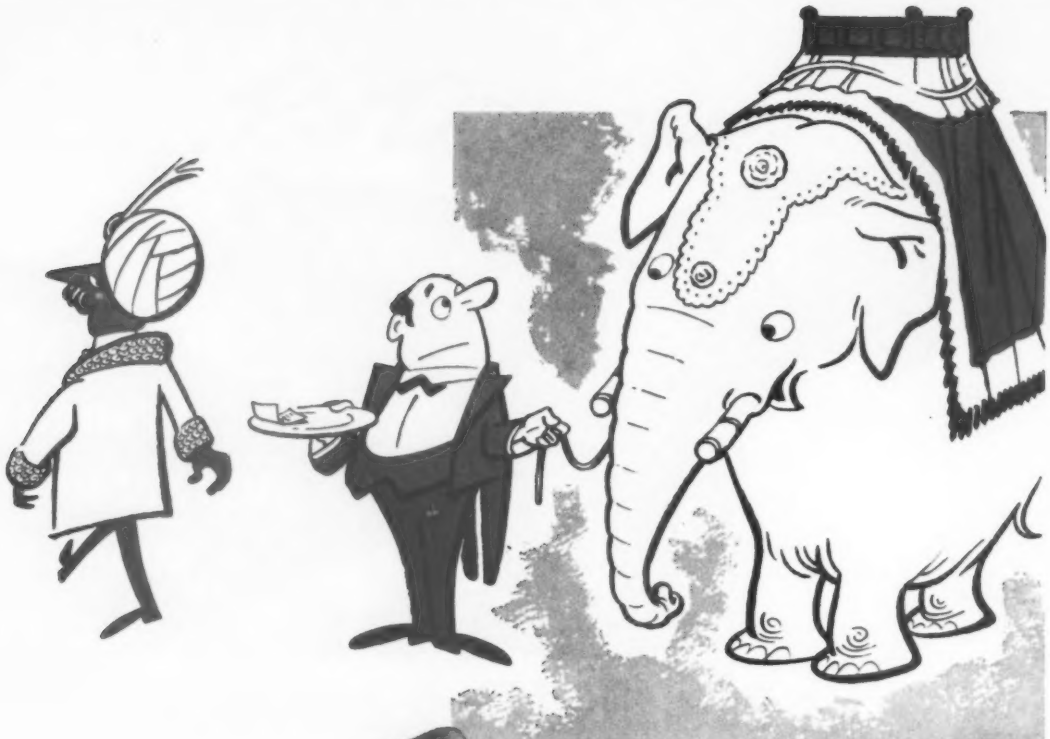

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Mechanical World

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Vol. 142 MARCH, 1962 Number 3512

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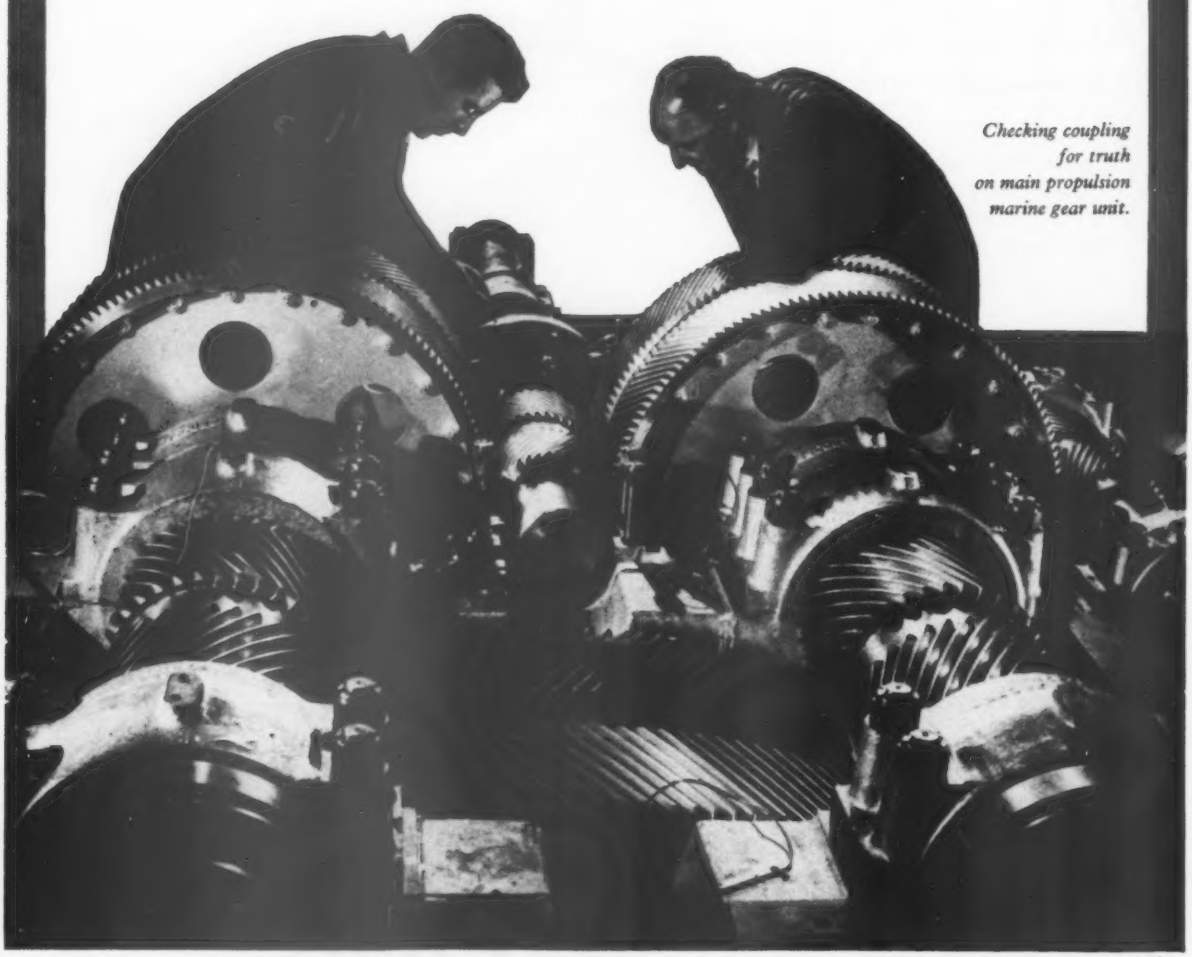

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Vocation

THE craft apprenticeship goes back to mediaeval times when methods and recipes were closely guarded secrets and the master often had something of personal value to hand on to his chosen successors. Since industrialization the purpose of apprenticeship has altered gradually and while still a means of training it is a means of controlling the numbers employed in any one trade. In its most modern form apprenticeship is a course of tuition and practical instruction accompanied by factory experience, and much more can be imparted in this way in a much shorter time than was usually absorbed by simply "picking it up" in the old five years arrangement which often left the apprentice with much still to be learnt as a journeyman.

On the matter of age of entry, the old idea that it should be from the sixteenth to the twenty-first birthdays and not a day later or sooner has largely gone, but not gone so far that anyone finding an aptitude in later life can readily enter a craft except as master of his own establishment, which of course suits the outstanding personality very well.

The problems of apprenticeship in the engineering industry has been the subject of discussion between the Minister of Labour, Mr. John Hare, and the Engineering Employers' Federation and the Confederation of Engineering and Shipbuilding Unions, both separately and more lately together, and a more detailed examination is proceeding particularly as regards a systematic scheme of training on a broad basis leading to a certificate of competence.

This basic idea has much to commend it: the problem will be how to introduce it so as to arouse interest widely and not, as might conceivably happen, cause a stifling of entry. Apart from a possible psychological advantage with a numerous middle group of "catching them young" in order to ensure a trade and prevent drifting, there is nothing perceivably critical in the age of entry. A mechanical bent is evident in many boys but they do not all get the opportunity of taking up training in the range of ages at present considered appropriate. Farmers' sons, in these days of mechanization, are an example and there are some who are not released from the ties of family farm life until they are past their majority and able to decide for themselves. The first possibility of entry could well therefore be outside the industry, at the technical school possibly where anyone of any age could learn profitably (whether or not followed up specifically) and acquire craft skill. From there the industry could recruit the able and adaptable and be free of the definitely unsuitable, and free of age restriction. Factory training would then have a starting point and be more appropriate, speedy or thorough as suitability required. There is, too, the possibility of the interested pupil acquiring more than one craft, for his private benefit if for no industrial purpose, though the latter is something which seems bound to arise in time. Training in this way is not new—it exists already in form and there are facilities in most places. It is the opening of the gate wider that is needed. Certification would be practicable and many people would take a pride in possessing certain knowledge and skill whether or not it meant their bread and butter, though to most it would be a way to fulfilment through life in industry.

LOG SHEET

Orbiting Observatory

A full-scale mock-up of the largest scientific satellite currently under development by the U.S. National Aeronautics and Space Administration has been unveiled by Grumman Aircraft Engineering Corporation, prime contractors and systems managers for the project. The mock-up represents the first phase of the orbiting astronomical observatory project and will lead to the production of two 3,300 lb flight models. NASA plan to launch the first flight model late in 1963. The satellite will be placed in a 500-mile circular orbit by an Atlas Agena-B vehicle and will monitor ultraviolet, infrared and X-rays from stars and provide information previously unobtainable, as most cosmic radiations are screened out by the atmosphere and cannot be measured directly by astronomers.

It will consist of a standard shell containing stabilization power and telemetry instruments, into which one or more separate experiments can be fitted for each flight. Astronomical equipment with reflecting mirrors up to 36 in. dia will be mounted in a cylindrical chamber running through its length. Paddles covered with solar cells will generate the 350 W required to operate the experiments and satellite equipment. The satellite stabilizing system will "lock" astronomical equipment on the star, sun or planet it is observing. Using its fine point control, it will be able to track a star with an accuracy of one-tenth of a second arc.

A satellite command system will receive ground signals to point and operate the satellite and its experiments. It will verify the commands it receives and store commands for execution as much as two hours later. A television tube will transmit pictures to ground stations to verify the direction in which the satellite is pointed. The telemetry system will send digital data and television signals in wideband transmissions, and information on experiments and the satellite operating conditions on narrowband. A "memory" will store at least 100,000 bits of information from the experiments for later read-out when the satellite is over ground stations. A minitrack network will track the satellite radio beacon, command its experiments and receive its telemetry. Large dishes will be erected at several minitrack stations for this purpose.

Proteus Turbo Generator

The first Bristol Siddeley 3 MW turbo generator to be ordered specifically for private industrial use has gone into service with English Clays Lovering Pochin & Co. Limited, at their china clay works in the St. Austell area of Cornwall. The new set, which can be remotely controlled from the station, is sited at Bugle, some five miles away, and will supplement the existing steam-driven machinery. It will be used to preserve both the integrity of supply in case of a power failure and to meet "on-peak" maximum demand periods during the winter months.

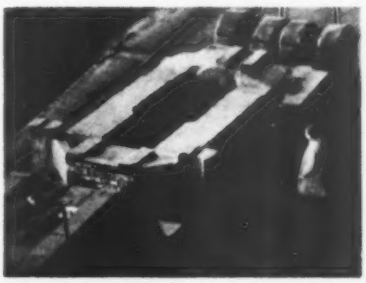
The generator, which is driven by a "free power turbine" industrial Proteus engine, has been developed as a lightweight plant intended to meet the requirements of public supply companies, large industrial concerns and contractors for peak-load operation, emergency supplies or for standby duties during planned maintenance. Advantages include low capital cost, fully automatic operation with remote control for starting and shutting down, instant readiness at all time (equivalent to spinning reserve) and high liability—coupled with the fact that the unit is compact, entirely self-contained and requires no cooling water supply. A mobile version, which can be transported as a single "power package" by land, sea or air, has also been developed.

V-BELT MOULDS.—Selecting ring moulds prior to the manufacture of automotive and industrial rubber V-belts at the Horninglow Road, Burton-on-Trent, factory of BTR Industries Limited. Some 15,000 V-belts varying in size from 15 in. to 180 in. dia are produced each week

Charles Keene College

The new Charles Keene College in Leicester, opened on December 1 last by the Minister of Education, is a result of the decision of the governors that the College of Technology and Commerce should concentrate largely on advanced work. The new college houses the Department of General Education and Junior Commercial courses and the Department of Mechanical Engineering Crafts and will eventually become a separate institution.

Alderman Charles R. Keene, C.B.E., J.P., after whom the college is named, has been chairman of the Governors of the Colleges of Art and Technology for over thirty-years and an outstanding figure in their life and development.

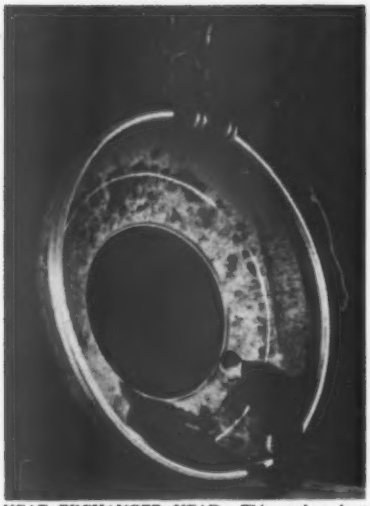


MILL HOUSINGS.—English Steel Corporation Limited is a sub-contractor to itself for part of the work involved in the corporation's £26,000,000 electric melting and rolling mill development scheme at Tinsley Park, Sheffield. The Brightside Foundry and Engineering Company Limited which is designing and building the major part of the rolling mill plant, have placed the sub-contract for casting the four steel housings for the two Brightside 32 × 84 in. reversing billet mills with one of the corporation's subsidiaries, English Steel Castings Corporation Limited. Each housing is 17 ft long by 11 ft 6 in. wide by 3 ft deep, weighs 42 ton finished and required 65 ton of steel for casting

Giant Computer

The Ferranti Atlas Computer to be installed in the University of London towards the end of 1963 at a cost of approximately £2M is claimed to be the most powerful in the world. Initial support is being given to the university by the British Petroleum Company, which is providing approximately a quarter of the cost and in return will have an agreed amount of time on the computer for a period of five years. Responsibility for the machine will be taken by the university's computer unit, which provides computing facilities for all colleges of the university and for many other outside organisations.

The work which Atlas will perform will range over many fields of science and engineering. Partial differential equations are very commonly used in engineering and other sciences to express dynamic



HEAT EXCHANGER HEAD.—This nuclear heat exchanger head has been spun and formed on a Rotarpress at the Greenwich Works of G. A. Harvey & Co. (London) Limited. It is 11 ft dia, weighs 8½ ton and is one of a number being made to the order of International Combustion Limited for Atomic Power Constructions Limited, who are building the Trawsfynydd Power Station for the Central Electricity Generating Board. Believed to be one of only four such machines in the whole of Europe, Harvey's Rotarpress produced this head from a blank of steel plate 14 ft dia and 3¼ in. thick

conditions, and their solution by numerical techniques often presents great difficulties but the universities have hardly tackled this field of work because of the lack of suitable computers. There are also important applications to electro-magnetic wave propagation, fluid dynamics, stellar structure and chemical engineering, for all of which a large, fast computer is essential.

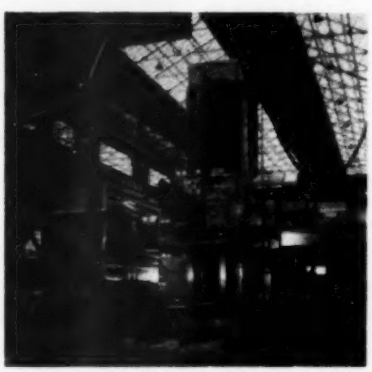
Atlas has been developed in co-operation with the University of Manchester where the first production model is being assembled and commissioned, and is designed as a general-purpose machine for both scientific calculation and data processing. Original technical features include a supervisory system for regulating the flow of work through the machine, a "page-address" system for more efficient utilization of storage space, a new type of semi-permanent store for frequently required data, and an adder with exceptionally fast carry-over. Simple instructions (e.g. addition) can be performed at a speed approaching a million per second.

C.E.G.B. Laboratories

The new research and development laboratories of the North Western Region of the Central Electricity Generating Board at East Didsbury, Manchester will be responsible for research studies which will lead to improved efficiency and availability of plant. They are in four sections. The physics section will be concerned with the transformation of the energy in coal and oil into electrical power; the chemistry section with the fields of corrosion and combustion; the electrical engineering section will develop circuits and instruments to cope with the trend towards automation, instrumentation and precision instrumentation, and the metallurgy section will be examining the problems involving materials in use in generating stations within the Region, and will be working to reduce repairs and maintenance costs involved in station operation in the field of materials, and will also be concerned with welding research.

New "Clearing" Factory

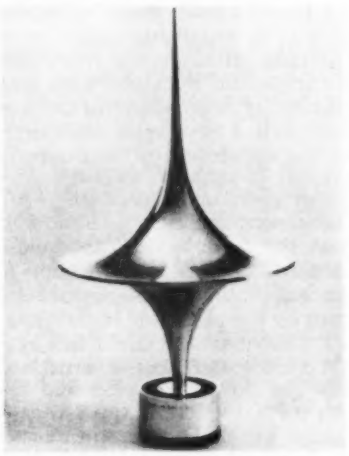
At the Scotswood works of Vickers-Armstrongs (Engineers) Limited, Newcastle upon Tyne, a new Power Press Division has been formed to satisfy the demand for presses designed by the Clearing division of U.S. Industries, Inc., manufactured



One of two 7 in. dia spindle Giddings and Lewis floor type milling, drilling and boring machines in the heavy machining shop at the Scotswood works of Vickers-Armstrongs (Engineers) Limited. The operation is the machining of T-slots in the base of the slide fabrication for a clearing hydraulic die spotting press

by Vickers-Armstrongs (Engineers) Limited, and sold in the U.K. under the name British Clearing by Rockwell Machine Tool Company Limited. The division also manufactures associated equipment, including Vickers-McKay metal-processing equipment.

Work formerly carried out at two different plants has been consolidated into one and a considerable investment in new plant and equipment has been made by Vickers in order to increase productive ability and efficiency. The division occupies about 22 acres and the works are equipped to fabricate up to 12 in. thick plate and have produced welded structures of up to 100 ton weight. The machine shops handle complete processing of the great variety of components required for products, from the smallest turned pins to the massive fabrications which are faced, milled and bored on large horizontal borers.



The Elastoplast first aid trophy. It is in solid silver and was designed by Robert Welch

New First Aid Award

Although the 1961 Factory Act now makes it compulsory for large factories to have at least one first aider on their staff, factories employing less than 50 people are still not compelled to employ trained first aiders even though a high percentage of work accidents occur on these premises.

To encourage both management and workers to take a greater interest in first aid Smith & Nephew Limited, makers of pharmaceutical and surgical products, will present their "Elastoplast Industrial First Aid Award" each year to the small factory, employing under 50 people, in England or Wales which, in the opinion of the judges achieves the highest proportion of first aiders on its staff and has provided the best first aid arrangements. The trophy is in solid silver and was designed by the British silversmith Robert Welch. Entry forms are available from local units of the British Red Cross (address in telephone book) or the Public Relations Officer, Smith & Nephew Limited, Bessemer Road, Welwyn Garden City, Herts.

The Interference of a Disc Type Milling Cutter in Cylindrical Work

The author presents an exact method of calculating the axial width of a helical slot milled by disc-type cutter. Two approximate methods are also given

By S. W. HUGO, A.M.I.Prod.E.

IT is well known that it is impossible to mill a helical slot of rectangular cross section in a cylindrical workpiece utilizing a disc type milling cutter. Continuous interference of the cutter edge from the bottom of the helix to the outer surface of the work gives a slot having sides with a developed curvature. A method is given for the calculation of the axial width of such a slot in terms of the variables involved.

The geometry appertaining to the type of cutter interference under consideration is presented in Fig. 1. From this it can be seen that opposite edges of the cutter interfere at points of intersection *I* on the work surface and that continuous interference is taking place for every point on the perimeter of the cutter from point *I* down to the maximum depth reached by it.

A view normal to the vertical plane *AB*, which contains one side of the cutter and its point of intersection with the work surface on that side, is projected to the right of Fig. 1. The point of intersection is that between the cutter circle and the work ellipse in this plane. It is required to solve for y which is a true length both in this view and in the normal section of the work projected to the left of Fig. 1.

The following expressions will be required:

Lead angle α

$$\text{Tan } \alpha = L/2\pi r_m$$

Note: r_m = mean radius, lead angle calculated at mean depth of cut.

Offset of cutter O

$$O = \tfrac{1}{2}\omega \tan \alpha$$

Axes of ellipse

$$m_e = r$$
$$M_e = r \sec \alpha$$

Co-ordinates with respect to ellipse

$$(x^2/M_e^2) + (y^2/m_e^2) = 1$$

Substituting for M_e and m_e,

$$x^2/(r \sec \alpha)^2 + y^2/r^2 = 1 \quad . \ . \ . \ . \ (1)$$

Co-ordinates with respect to circle

$$(x + O)^2 + y_1^2 = R^2$$
$$y + y_1 = R + r - d$$
$$y_1 = R + r - d - y$$

Substituting for y_1

$$(x + O)^2 + (R + r - d - y)^2 = R^2 \quad . \ . \ . \ . \ (2)$$

A general solution for y may be obtained from the expressions (1) and (2) but the resulting expression is somewhat complicated and it is more helpful to consider a particular case.

Example

Work *o*/diameter 2 in. Cutter diameter 4 in. Cutter width $\frac{1}{4}$ in. Depth of cut $\frac{1}{4}$ in. Lead $1\frac{1}{2}$ in.

From which: $r = 1$ in. $r_m = \frac{7}{8}$ in. $r_r = \frac{3}{4}$ in. $R = 2$ in. $\omega = \frac{1}{4}$ in. $d = \frac{1}{4}$ in. $L = 1\frac{1}{2}$ in.

$$\text{Tan } \alpha = 1\tfrac{1}{2}/(2\pi \times \tfrac{7}{8}) = 0{\cdot}2730$$
$$\alpha = 15^\circ 16'$$
$$r \sec \alpha = 1 \times 1{\cdot}0366$$
$$(r \sec \alpha)^2 = (1{\cdot}0366)^2 = 1{\cdot}075$$
$$x^2/1{\cdot}075 + y^2/1 = 1$$
$$x^2 + 1{\cdot}075\, y^2 = 1{\cdot}075$$

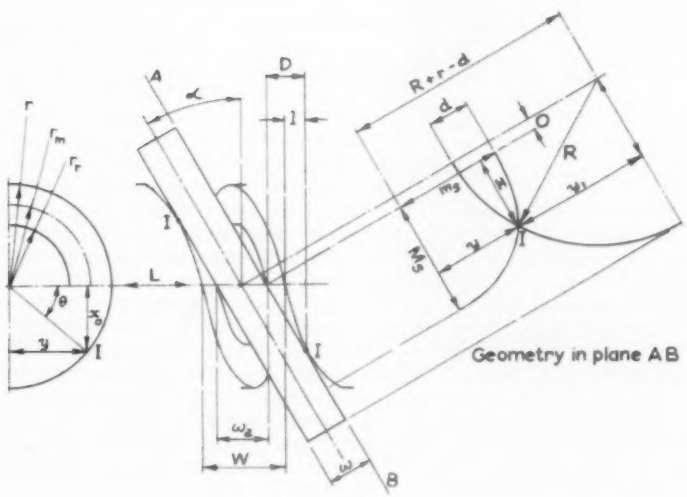


Fig. 1.—Intersection of disc type cutter with cylindrical work

I = Point of intersection of cutter with surface of work.
r = Maximum radius of work.
r_m = Mean radius of work.
r_r = Root radius of work.
R = Radius of cutter.
w = Width of cutter.
w_a = Axial width of cutter.
d = Depth of cut.
α = Lead angle.
L = Lead of work.
M_e = Semi-major axis of work ellipse.
m_e = Semi-minor axis of work ellipse, (= r.)
O = Offset of cutter centre line.
x & y = Co-ordinates of point of intersection with reference to ellipse, (work).
$(x+O)$ & y_1 = Co-ordinates of point of intersection with reference to circle, (cutter).
θ = Angular offset of point of intersection in plane normal to work axis.
x_o = Offset of point of intersection from centre line of work in normal plane.
l = Partial lead advance over angle θ.
D = Cutter departure from point of intersection.
W = Axial width of slot at surface of work.

$$x^2 = 1{\cdot}075\,(1-y^2)$$
$$x = \sqrt{1{\cdot}075\,(1-y^2)}$$
$$O\text{ (offset)} = \tfrac{1}{8} \times 0{\cdot}2730$$
$$= 0{\cdot}0341$$
$$(x + 0{\cdot}0341)^2 + (2 + 1 - \tfrac{1}{4} - y)^2 = 4$$
$$x^2 + 0{\cdot}0682x + 0{\cdot}00116 + 7{\cdot}5625 - 5{\cdot}5y + y^2 = 4$$

Substitute value for x^2 and x,

$$1{\cdot}075\,(1-y^2) + {\cdot}0682\sqrt{1{\cdot}075\,(1-y^2)} + 0{\cdot}00116 + 7{\cdot}5635 - 5{\cdot}5\,y + y^2 = 4$$

which simplifies to,

$$0{\cdot}005625y^4 + 0{\cdot}824y^3 + 29{\cdot}5591y^2 - 51{\cdot}08y + 21{\cdot}495 = O$$

Obviously y is smaller than m_s. Let $y = 0{\cdot}8$ and substitute in the above expression (trial and error). It will be found that this value for y will satisfy the equation giving an error of $+$ ·0188.

Using the value $y = 0{\cdot}8$ and considering the normal section projected to the left of Fig. 1.

$$\text{Cos}\,\theta = y/r = 0{\cdot}8$$
$$\theta = 36^\circ\,52'$$
$$I = (36^\circ\,52'/360^\circ) \times 1\tfrac{1}{2}\text{ in.} = 0{\cdot}153\text{ in.}$$
$$x_o = r \sin\theta$$
$$D = x_o \tan\alpha$$
$$= r \sin\theta \tan\alpha$$
$$= 0{\cdot}164\text{ in.}$$
$$\omega_a = 0{\cdot}250 \sec 15^\circ\,16'$$
$$= 0{\cdot}259\text{ in.}$$
$$W = \omega_a + 2\,(D - I)$$
$$= 0{\cdot}259 + 2\,(0{\cdot}164 - 0{\cdot}153)$$
$$= 0{\cdot}281\text{ in.}$$
$$\text{Interference on one side} = (0{\cdot}281 - 0{\cdot}259)/2$$
$$= 0{\cdot}011\text{ in.}$$

In practice the width of the slot would be somewhat greater than 0·281 in. due to the cutter cutting oversize on its nominal width. The details of the work have in fact been taken from the milling of a triple start helix and Fig. 2(a) shows the thread pitch and the width of the crest. The value calculated above is maintained in practice. Fig. 2(b) indicates the nominal flank angle.

$$\text{Tan}\,f = 0{\cdot}011/0{\cdot}250 = 0{\cdot}044$$
$$f = 2^\circ\,31'$$

The advantages of the Acme thread form can be appreciated. The included angle of 29° is such that interference will not occur under normal conditions in thread milling with the cutter inclined to the helix angle of the work. The same applies to the standard 12° side angle on milling cutters. The interference of cutters not inclined to the helix angle of the thread as in thread mill hobbing with an annular hob is, of course, rather a different case.

It can be seen that repeated calculation along the above lines would give sufficient ordinates to enable the curve of interference to be drawn if it were of sufficient interest.

Two approximations to the above method are now presented.

First approximation

This is indicated in Fig. 3. All values in this figure are the same as those shown in the right hand projection of Fig. 1. except that the work ellipse is approximated to a circle of radius C where C is equal to the mean value of the semi-major and semi-minor axes of the work ellipse.

$$C = (M_s + m_s)/2 = (1{\cdot}0366 + 1{\cdot}000)/2$$
$$= 1{\cdot}0183\text{ in.}$$

Considering the triangle HCR, H is taken to be equal to $(R + r - d)$; C is as calculated above and R is the radius of the cutter. Using the cosine rule angle ϵ is found to be 34° 42′ and angle δ to be 56° 3′. y is found from these to be 0·834 in.

Working along exactly the same lines as in the previous solution the interference on one side can be found to be 0·012 in. giving a width of slot of 0·283 in., an error of 0·002 in. over the more exact method.

Second approximation

This is indicated in Fig. 4. The cutter offset is completely neglected and the work ellipse is approximated to a circle of radius r, (the actual work radius), thus a calculation for angle θ in these terms gives a value which can be taken to be equivalent to the angle θ in the view to the left of Fig. 1.

Using the cosine rule angle θ is found to be 33° 48′ and y to be 0·831 in. Working as before the interference is calculated to be 0·011 in. on one side giving a width of slot of 0·281 in., a result no different from that arrived at in the more exact method.

Conclusion

The results arrived at above were obtained by using a slide rule. No doubt some differences would be apparent using more accurate methods but it is doubtful if such differences would have any practical significance, certainly not in the case of milling; grinding possibly.

It is obvious that fairly wide differences in the values obtained for y and θ have little effect on the partial lead advance I and hence on the interference. It therefore appears reasonable to conclude that, in general, the simple approximation is adequate for this type of problem.

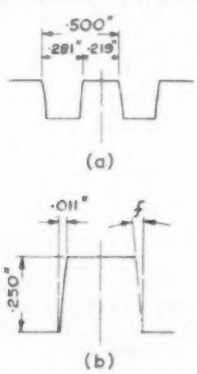


Fig. 2.—Thread dimensions

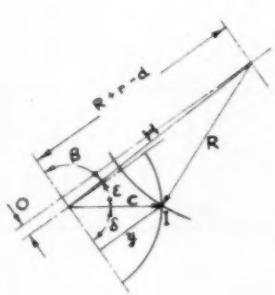


Fig. 3.—First approximation

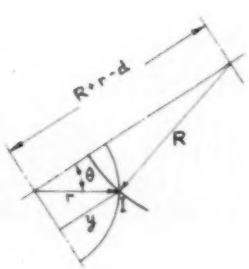


Fig. 4.—Second approximation

Preliminary Design of Gas Turbine Plant—II

The second of a series of articles presenting a full treatment of design procedure which will be accompanied by a completely worked example and all relevant data

By W. R. THOMSON, B.Sc.Tech.

3.3.1. Standard fuel

A great simplification in calculations results from the assumption of a standard fuel of such carbon to hydrogen ratio that the molecular weight of the fuel is the same as that of air, hence the molecular weight of the products of combustion is likewise the same and therefore independent of the fuel-air ratio. This fuel is 86·08% carbon and 13·92% hydrogen and corresponds very closely to ordinary kerosene. Its lower calorific value may be taken as 10,300 Chu per lb. $k - k_v = 0{\cdot}0686$ for air and all products of combustion.

3.3.2. Effective calorific value and fuel-air ratio

The E.C.V. is the heating value of the fuel remaining when the fuel has heated itself up to the final temperature T_e in Fig. 1. Then the fuel-air ratio is calculated from

Table III.—EFFECTIVE CALORIFIC VALUE OF STANDARD FUEL

$T°K$ after combustion ("T_{max}")	Deduct from 10,300 Chu/lb	Mean difference for 10°	Deduct further for Dissociation
300	0	5	
400	50	6	
500	110	6	
600	170	6	
700	230	6	
800	290	7	
900	360	7	
1000	430	7	
1100	500	8	
1200	580	8	0
1300	660	8	$0{\cdot}3/q$
1400	740	8	$0{\cdot}5/q$
1500	830	9	$0{\cdot}9/q$
1600	910	9	$1{\cdot}5/q$
1700	1000	9	$2{\cdot}2/q$
1800	1090	9	$3{\cdot}0/q$
1900	1180	9	$4{\cdot}0/q$
2000	1270	9	$5{\cdot}5/q$

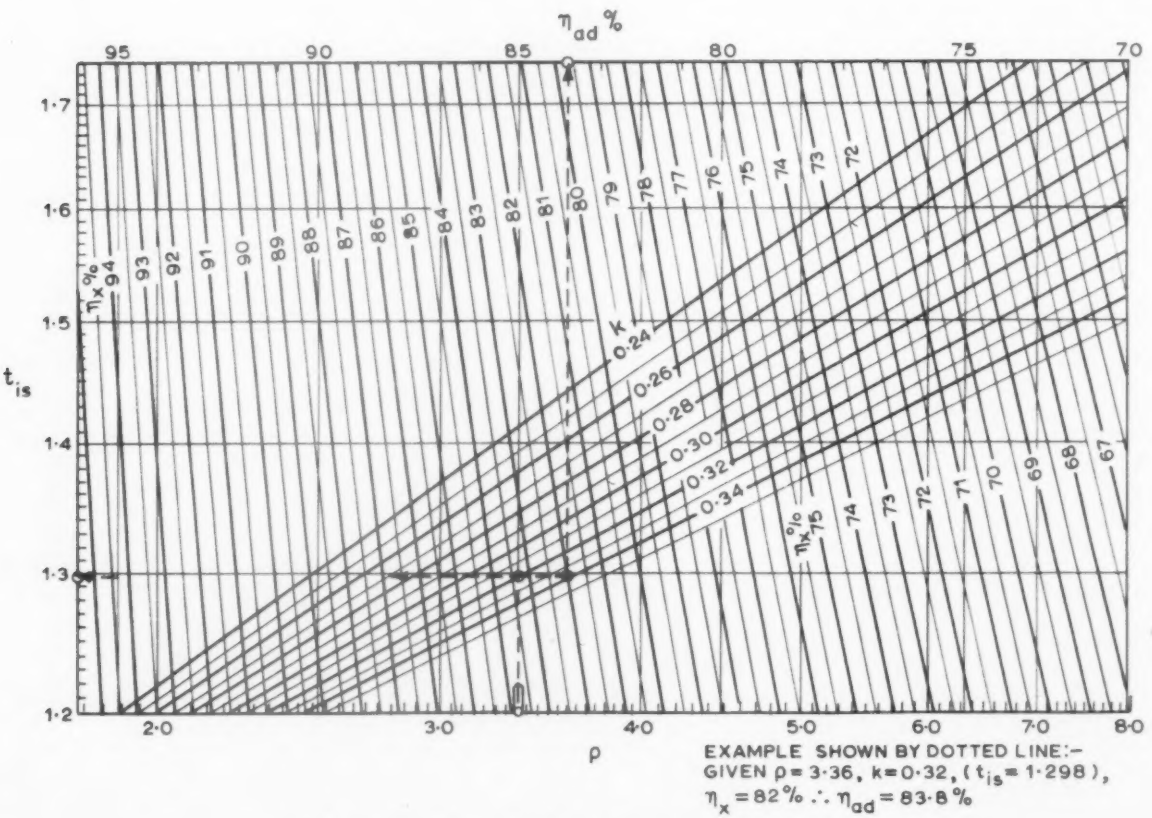


Fig. 3.—Expansion: Conversion of polytropic to adiabatic efficiency and vice versa

$$q = \frac{H_c - H_e}{\eta_{ic}\,(\text{E.C.V.})}$$ where η_{ic} = combustion efficiency and H_c and H_e are the enthalpies for *air*.

3.3.3. Effective calorific value of standard fuel

Table III gives the deduction to be made from the standard lower calorific value (10,300 Chu per lb) for any upper temperature (T_c in Fig. 1) up to 2000° K at 100° C intervals with interpolation for intermediate temperatures. Additionally, for temperatures above 1400° K the table gives the further deduction to be made to allow for dissociation (by a process of trial and error).

3.4. Expansion

The turbine works with less than perfect efficiency. In Fig. 1 the path *ci* (for the first or compressor-driving turbine) indicates the ideal, isentropic, or adiabatic expansion whilst the actual path—idealized as a "polytropic" in path *cf*—must show some entropy increase. The efficiency of the process is described in two quite different ways, both essential in the cycle calculations. For the second or power turbine the isentropic path is *f k* whilst the polytropic path is *f d*.

3.4.1. Adiabatic efficiency in expansion

$$\eta_{iad} = \frac{H_c - H_f}{H_c - H_i}$$ which may be approximated with negligible error to the usual

$$\eta_{iad} = \frac{T_c - T_f}{T_c - T_i}$$ for the first turbine.

For the second turbine

$$\eta_{iad} = \frac{H_f - H_d}{H_f - H_k}$$ leading to

$$\eta_{iad} = \frac{T_f - T_d}{T_f - T_k}$$

3.4.2. Polytropic efficiency in expansion

$$p = \frac{P_c}{P_f} = \left(\frac{T_c}{T_i}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{T_c}{T_f}\right)^{\frac{\gamma}{\eta_{ix}(\gamma-1)}}$$

$$\text{whence } \eta_{ix} = \frac{\log T_c/T_f}{\log T_c/T_i}$$

3.4.3. Conversion of efficiencies in expansion

η_{iad} and η_{ix} are connected thus

$$\eta_{iad} = \frac{1-(1/p)^{\eta_{ix}(\gamma-1)/\gamma}}{1-(1/p)^{(\gamma-1)/\gamma}}$$

The graph in Fig. 3 converts one to the other for any case. The normal order of reading is p, k, η_{ix}, to give η_{iad} on the top scale as in the example marked on the graph where for the case $p = 3{\cdot}35$, $k = 0{\cdot}32$, $\eta_{ix} = 82\%$, if required $t_{is} = 1{\cdot}297$ and $\eta_{iad} = 83{\cdot}8\%$.

If, however, η_{iad} were given and η_{ix} required, say $p = 3{\cdot}35$, $k = 0{\cdot}32$, $\eta_{iad} = 87\%$, then t_{is}, of course equals 1·297 as before and one would stop along the t_{is} line at $\eta_{iad} = 87\%$ to read $\eta_{ix} = 85{\cdot}5\%$.

3.4.4. Work done in expansion

The work available from the first turbine in Fig. 1

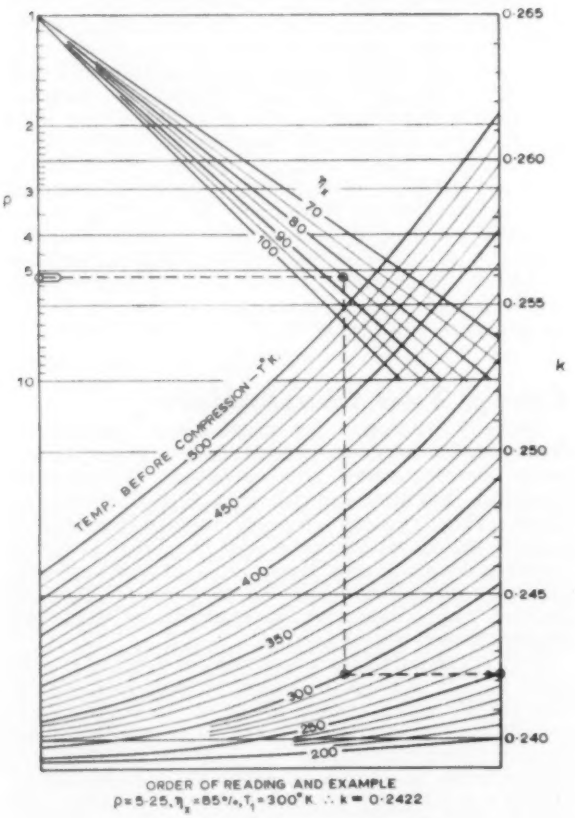


Fig. 4.—Approximate k for a compression

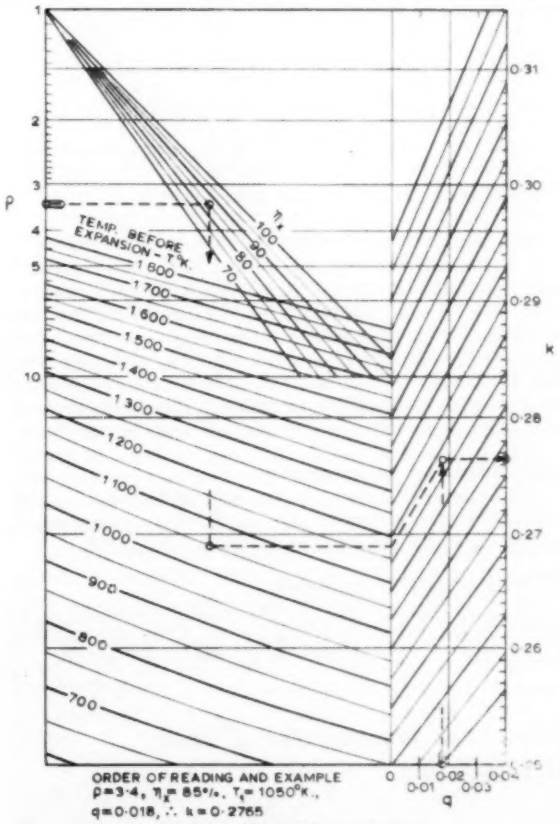


Fig. 5.—Approximate k for an expansion

$= H_c - H_f$ (per lb of air)
$= k\,(T_c - T_f)$ where k should be the mean

specific heat between T_c and T_f, but normally it is sufficiently accurate to use the *true* specific heat at the *mean* temperature $\frac{1}{2}\,(T_c + T_f)$ this necessitating only one table of values for k.

In the cycle chosen (Fig. 1) the work available from the first turbine must balance (with some allowance, say 0·5%, for mechanical friction) the work absorbed by the compressor, $H_b - H_a$, i.e.

$$H_c - H_f = 1{\cdot}005\,(H_b - H_a).$$

For the second turbine in Fig. 1 the work available for, say, driving an electric generator is $H_f - H_d$.

3.4.5. Enthalpy of "Gas"

The values of H_{gas} for the products of combustion can be obtained from Table I by using the values of θ_{gas}, given at 10° C intervals from 200° K to 2000° K and by interpolation to nearest degrees, in the equation

$$H_{gas} = H_{air} + \frac{q}{1+q}\,\theta_{gas}$$

Thus for a gas at $T = 1134°$ K and $q = 0{\cdot}0272$,

$$H_{gas} = 285{\cdot}64 + 0{\cdot}4 \times 2{\cdot}78 + \frac{0{\cdot}0272}{1{\cdot}0272}\,(340 + 0{\cdot}4 \times 5)$$

$$= 285{\cdot}64 + 1{\cdot}11 + 9{\cdot}05 = 295{\cdot}80 \text{ Chu per lb gas.}$$

3.4.6. True specific heat of "gas" at constant pressure

The values of k_{gas} for the products of combustion can be obtained from Table II by using the values of θ_{gas}, given at 10° C intervals from 200° K to 2000° K and by interpolation to single degrees, in the equation

$$k_{gas} = k_{air} + \frac{q}{1+q}\,\theta_{gas}$$

Thus for a gas at $T = 1134°$ K and $q = 0{\cdot}0272$

$$k_{gas} = 0{\cdot}2780 + 0{\cdot}4 \times 0{\cdot}0004 + \frac{0{\cdot}0272}{1{\cdot}0272}\,(0{\cdot}487 + 0{\cdot}4 \times 0{\cdot}002)$$

$$= 0{\cdot}2780 + 0{\cdot}00016 + 0{\cdot}01326 = 0{\cdot}2914$$

4. Preliminary estimate of k

In either a compression or expansion calculation it may be that the initial temperature only is known together with the pressure ratio. An estimate must then be made of the value of k for the process so that, from the pressure ratio, the temperature ratio and hence the final temperature (both approximate) can be calculated. Then a better value of k is available at the mean temperature and adjustment is made until balance is attained.

4.1. Estimating k in compression

Fig. 4 provides a ready means of estimating k. In this graph the order of reading is p, $\tau_i x$, T before compression, and hence k. An example is shown on the graph.

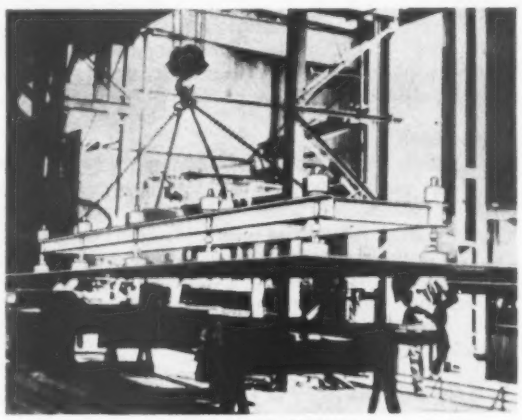
4.2. Estimating k in expansion

Fig. 5 provides a ready means of estimating k. In this graph the order of reading is p, $\tau_i x$, T before expansion q, and hence k. An example is shown on the graph.

To be continued.

Electro Magnetic Plate Handling

Melbro Magnetic Tools Limited, 2a Alexandra Road, Manchester, 15, have developed a range of beams for horizontal and near-vertical lifting, which utilize small magnets, and are designed to handle plates up to 20 ton of an infinite variety of dimensions. This has been achieved by the availability of four basic lifting magnets with capacity of ½, 1, 2 and 3 ton, which can be arranged in numerous magnet plan patterns. Switching can be provided to use all magnets or groups of magnets. The complete control



Magnetic plate handling beam

of all functions of the beam, which include rotating the beam, can be done from the crane cab.

Safety has been extensively studied and the beams offered are: horizontal 5: 1; near vertical, 12: 1.

Emergency batteries 'float' at a slightly lower voltage in the feed circuit so that should the mains supply or the feed from the transformer fail, current from these batteries flows into the circuit instantaneously and their capacity is adequate to maintain the load for a period of 30 min. Charging equipment is provided so that when the supply is restored the batteries are re-charged to full capacity. Three operator controls are provided: (1) a test indicator to enable the operator to determine the conditions of the batteries at any time; (2) on off switching for the magnets is effected through a latching contactor; (3) a voltage regulator to enable the operator to lift off single plates from a stack by reducing the magnetic field. Arrangements can be made to fit this equipment to any type of crane.

Creep Test Controllers

Specially developed for metal creep and rupture testing applications, two transistorized resistance thermometer controllers have been introduced by Associated Electrical Industries Limited, P.O. Box One, Harlow, Essex. They provide accurate furnace temperature control and enable long term tests to be carried out on metals under stable conditions in spite of wide variations in supply voltage and ambient temperature. They are capable, with suitable oven arrangement, of controlling temperatures to within ± 0·1° C.

Both controllers have a temperature range of 0° C to 1200° C. The RT3 is for on/off proportional control. The RT3R, which utilizes silicon controlled rectifiers, enables fully proportional control to be applied to any furnace within the current rating of its rectifiers. The only controls on both instruments are for temperature setting and loop gain sensitivity adjustment. Both types occupy a panel cut-out space of only 5¼ × 5½ in.

Specific Speed of Pumps

The discrepancies which commonly arise with specific speed evaluation, its significance as applied to type of pump and other criteria governing final choice

THE parameter specific speed is commonly used as a basis for the evaluation or selection of a particular pump for a specific duty. It is important, however, to appreciate that it can only be applied in general terms and that quoted out of context it can be misleading, both as regards the units employed in arriving at the specific speed figure and even to the method of derivation.

Pump types may be classified, broadly, as centrifugal, rotary and reciprocating, depending on their basic design and performance characteristics. Since 'centrifugal' pumps in this general classification embraces both mixed flow and axial flow (propeller type) pumps, this class is more correctly termed rotodynamic pumps and sub divided into centrifugal, mixed flow and axial flow types —a classification more commonly applied in this country whereas America generally accepts the broader description of grouping all three sub-types under the general heading of centrifugal pumps.

The parameter "specific speed" belongs essentially to the rotodynamic group. Confusion arises from the fact that the term specific speed is also sometimes used as a matter of convenience to describe a different parameter in the case of rotary pumps, and even other types of positive displacement pumps, when the prospective user may use such data, quite incorrectly, for comparative purposes. Properly, some other term—such as specific revolutions, should be used in such cases, but a general safeguard is to accept that specific speed figures, when quoted, are only valid in the case of rotodynamic pumps and where quoted for other types refer not to true specific speed as such but to a convenient parameter applicable only to the type of pump concerned.

Specific speed is readily calculated as—

$$\text{specific speed} = N\sqrt{Q}/H^{0.75}$$

where N = speed of pump, rpm
Q = discharge or flow rate at the design point
H = total or effective head at the design point

This is a dimensional quantity and thus the actual value is dependent on the units employed. Standard British practice is to calculate Q or flow rate in terms of Imperial gallons per minute and head in feet. American practice employs the U.S. gallon for flow rate and thus, with head still in feet, yields a different figure for specific speed for an otherwise identical pump. The conversion factor to arrive at a consistent figure is 1·095 i.e.

Specific speed (British) = 1·095 × specific speed (American).

Standard Continental units for flow rate are litre per second, with head measured in metres, whilst other units inconsistent with the normal British standard may be employed, such as rendering flow rate in cubic inches per second, whilst in other cases the head may be rendered in terms of pressure equivalent. Failing information to the contrary, it is usually safe to assume that specific speed has been calculated on the standard units mentioned, according to origin, which can then be corrected to a common standard—e.g. British specific speed for direct comparison. Without such correction considerable discrepancies can arise.

A further source of inconsistency is that with double- or multi-rotor pumps, differences exist in evaluating the flow rate. Flow rate may be taken as the total output, or output divided by the number of impellers. There appear to be no set rules on this point although in the case of double-entry centrifugal pumps the total discharge

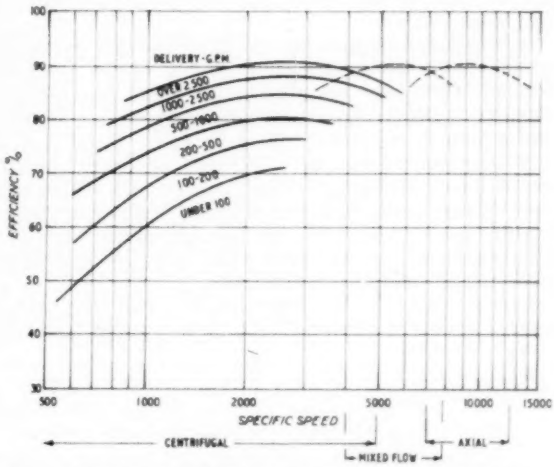


Fig. 1.—Typical general relationship between specific speed and efficiency

should be considered as correct. In the case of axial flow type pumps, however, where there is more than one rotor working in parallel on a common shaft, then correctly the performance of the individual rotor should be considered—i.e. true discharge for specific speed calculation equals total discharge/number of individual rotors.

Specific speed is independent of the size of the pump and rather relates to the shape or form of the pump rotor or impeller, i.e. it is determined by the profile or general shape of the rotor for maximum efficiency. In a similar manner it is largely independent of shaft speed as a major criterion, even though shaft revolution is a factor of specific speed. A high specific speed may be associated with a low shaft speed and vice versa; but equally a change in specific speed for a particular type of pump may result directly from a change in design operating speed.

Overall design characteristics represented by specific speed are, in fact, somewhat general. For a given specific speed, pump efficiency and performance may vary appreciably with different detail design of rotor and internal passage shape, etc. Thus although a certain specific speed is usually taken to be characteristic of a particular form of rotor, this is only an assessment of overall rotodynamic pump design and performance in a broad sense.

The typical (general) relationship between specific speed and efficiency is shown in Fig. 1. Specific speed in the case of pure centrifugal pumps is usually limited to a maximum of about 5000, with mixed flow rotor designs

covering the range 4000 to 7000 and axial flow designs from 6000 to 12,000. These represent the limits between which a good efficiency figure can be realized for the type of pump concerned, governed by the basic characteristics of the rotor and attendant losses. Whilst it is readily possible to design for a specific speed outside the ranges indicated, efficiency would tend to be low as a consequence and another type of pump would be preferred. Thus a centrifugal pump for a specific speed much in excess of 5000 would require a very broad, low aspect ratio rotor with high losses for purely centrifugal flow, and a mixed flow rotor giving both centrifugal and axial flow would be a much better—and more efficient—proposition. At even higher specific speeds pure axial flow would show minimum losses, calling for a propeller-type rotor.

It is generally conceded, in fact, that the optimum specific speed for centrifugal pumps is of the order of 2000 to 3000, corresponding to the broad peak of the efficiency curves, which is largely independent of flow rate although the actual efficiency figure tends to fall with decreasing flow rate. Operating at lower specific speeds—and particularly with low outputs—efficiency tends to fall rapidly as the rotor has to become narrower. Equally, axial flow tends to become more inefficient with decreasing specific speed which is why such designs are restricted to higher specific speeds.

This also leads to the interesting fact that with higher specific speeds the overall size of the pump tends to decrease—firstly because of the corresponding reduction in rotor diameter in the case of centrifugal pumps, and then the further reduction in casing diameter in changing over to propeller-type rotors and axial flow. A point to be borne in mind, however, is that with high specific speed the head/flow rate curve may show an appreciable dip instead of being a smooth curve which may not render the selection suitable if demand is such that the pump may have to be operated at or near the dip. Depending on the system demand characteristics, this could lead to unsatisfactory performance, such as hunting.

In general, calculation of the specific speed associated with any particular requirements indicated the type of pump most likely to be suitable. Thus given head, discharge rate and desirable pump speed, specific speed can be calculated from these data. If lower than 4000, a centrifugal pump should be the most satisfactory choice (considering only rotodynamic pumps). If above 7000, an axial flow propeller pump is indicated. For intermediate values, a mixed flow pump would probably be the most satisfactory.

However, pump speed is unlikely to be fixed at this stage and thus the choice is likely to be far more open. Thus for a given head and discharge rate all three types may be suitable, at different driving speeds consistent with rendering their respective specific speeds within the desirable range for maximum efficiency. This can then take into consideration other factors, such as decreasing pump size with increasing specific speed, and head-capacity characteristic curves. It may be, for example, that the low specific speed pump may prove undesirably bulky, or the flat characteristics of the head-capacity curve near shut-off undesirable for the particular application and so on. Choice is not restricted to rotodynamic. pumps alone, although only these can be type investigated on a preliminary basis by considerations of (true) specific speed.

Another important consideration may be suction head, which is directly related to specific speed. There is a definite relationship between head, capacity and safe suction lift which can be employed for a given specific speed range for different types of pumps, i.e. a maximum safe specific speed for a particular type of pump used under particular conditions. In general, this resolves itself into a decrease in permissible suction head with increasing specific speed. Thus whilst a centrifugal pump with an inherently low specific speed may accommodate a reasonable suction head, a propeller-type pump giving a similar total head may have a very low permissible suction lift—or even demand a suction head, for satisfactory performance.

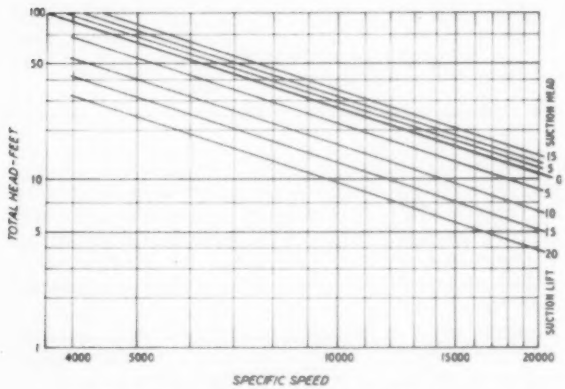


Fig. 2.—Head/speed chart for mixed and axial flow pumps

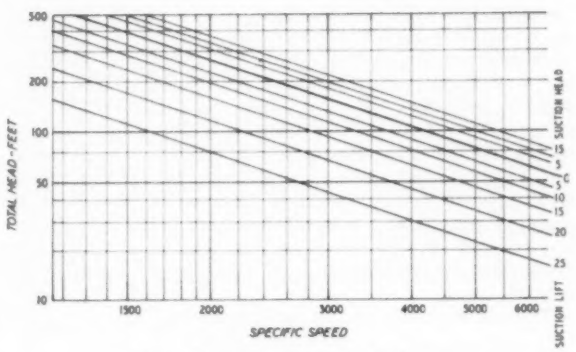


Fig. 3.—Head/speed chart for centrifugal pumps

Specific characteristics of this nature may be expressed in the form of charts, representing average recommendations or known performance for different types of pumps; or taken into account by manufacturers in recommending a particular pump for a particular application. Fig 2 shows, in simplified form, a chart based on the (American) Hydraulic Institute recommendations for mixed flow and axial flow pumps (specific speed corrected to British units), showing the variation in suction lift permissible (or suction head required) for satisfactory performance for a given total head and specific speed. Given total head and specific speed, maximum permissible value for suction head can be read off direct; or given head and required suction lift, the maximum permissible speed for satisfactory performance. Similar curves for centrifugal pumps are given in Fig. 3.

Progress in the Development of Titanium

Titanium is established as an addition to the composition of stainless steel, as a substitute for tungsten carbide in cutting tools, in arc-lamp electrodes, mordants, and glaze pigments. Now it has become an important alloying element. In this article other applications of titanium are mentioned and some recent research outlined

TITANIUM has a high resistance to corrosion and has high strength which it keeps well at intermediate temperatures. It also has low specific gravity, an attractive modulus of elasticity, a high melting point and can be employed as a constructional material wherever its cost is not prohibitive. The metal has been cast in two-ton ingots and rolled into strip. Ferro-titanium is used in the steel industry as a deoxidizer to prevent the occurrence of segregation and objectionable inclusions, and to control grain size.

Titanium is also used in steels for vitreous enamelling, where its addition to the extent of about 5% eliminates blistering from the surface of the finished product. Titanium alloys are becoming of increasing importance in the jet-engine and air-frame industries, but here difficulties have been experienced which could be ascribed to hydrogen contamination. It was realized that an essential point was to prevent hydrogen from getting into the metal and it was found that considerable absorption of hydrogen (as regards its harmful influence) might take place as a result of sodium hydride descaling, and of pickling in a bath of 10% nitric with 2% hydrofluoric acid. Research has revealed that the addition of titanium dioxide to the ordinary hydride bath results in a noteworthy decline in hydrogen absorption by titanium of commercial purity. The descaling rate is not affected and a smooth, bright surface finish is obtained.

There are certain dangers attached to the use of titanium dioxide additions to a hydride bath as regards evolved hydrogen. For this reason pilot lights must always be kindled and located close to the surface of the bath to ignite the hydrogen if too swiftly evolved. Pigment qualities of titanium dioxide must not be employed as the fine size sets up a very quick reaction and the bath might boil over. The bath can be regulated merely by adding enough titanium dioxide at regular intervals to keep it saturated with the products of reaction, as calculated from the sodium and caustic added to the bath.

The influence of certain elements such as carbon, oxygen, nitrogen and hydrogen on titanium designed for use for structural components of aircraft and ordnance showed that insufficient knowledge existed regarding the rate of diffusion of carbon in alpha and beta titanium. Research into this aspect demonstrated that within the limits of experimental error, the rate of diffusion of carbon is independent of concentration

During the quenching of alloyed titanium from the beta field, a martensitic transformation may take place. It was designed to discover microscopically how the alpha phase changes on reheating to that of equilibrium as dictated by the phase diagram. Summing up the complex pattern of microstructural modifications displayed, it may be said that the raising or lowering of the tempering temperature seems to affect only the kinetics of the processes involved, and not their character. Alpha particles appear to be precipitated in the form of needles in alloys of titanium with 13% molybdenum.

Much work has been done on the influence of heat treatment and composition on the mechanical properties of titanium alloys, and often large grain size and needle-like structures have been made responsible for poor properties obtained. Some metallurgists felt, however, that large grain size of needle structures need not always be injurious to the mechanical properties of the alloys. Accordingly, the effect of grain size variation and form on the mechanical properties of titanium and its alloys was investigated, with particular reference to fabrication and performance, tensile strength, hardness, bend properties, impact and fatigue endurance limits. Alloys of titanium, chromium and molybdenum combined were used as the alloys to be studied.

The data obtained showed that for unalloyed titanium, grain size or form has only a minor influence on mechanical properties. The grain size of metastable beta alloys, it is suggested, also have only a minor influence on mechanical properties as long as the alloy is single phase. Alpha in the structure reduces tensile ductility and impact resistance, but notched fatigue properties seem to be almost uninfluenced by modifications in grain size or microstructure. Alpha/beta alloys experience only minor changes of properties with change of grain size. The fatigue endurance limits of the alloys generally are not affected by grain size or form, irrespective of alloy content, but tensile strength is considerably increased by alloy content.

An alloy of 6% aluminium, 4% vanadium, balance titanium, has been developed in the United States. It was shown to possess a good combination of tensile strength and ductility as well as high impact resistance and high strength at elevated temperatures. It has now become one of the most frequently used commercial alloys for ordnance, air-frame and aircraft engine applications, and is also used in the form of wire, sheet, bar and forgings. The most satisfactory forms of heat-treatment had, however, to be established, and research was initiated for this purpose. The conclusions appear to be that the alloy has a wide range of hot working temperatures, but variation of the working temperature between 760° and 950° C does not greatly influence mechanical properties obtained by any specific heat treatment. Duplex heat treatment will give moderately high levels of strength with good ductility. A wide range of mechanical properties (99 to 123 ton sq. in. tensile and 70 to 116 ton sq in. yield strength) may be obtained by means of solution treatments from 840° to 950° C and ageing at temperatures from 480° to 940° C.

Strengths as low as 58 ton/sq in. may be had by slow cooling from the solution temperatures. The 840° C solution treatment gives the lowest yield-tensile ratio and also produces good machinability and low temperature formability. Later ageing will bring up the strength to the highest possible levels.

Titanium and its alloys have a rather lower elastic modulus (E) to density (ρ) ratios than other comparable engineering materials. It was felt that something might be done by the addition of alloys or by modification to improve the structure so work was done to decide whether or not this was possible. The studies showed that a 20% increase in the E/ρ parameter could be realized. Such an improved alloy would have to be predominantly alpha phase, and an aluminium alloy gave a notably improved elastic modulus. As an alternative to aluminium, carbon or boron as dispersions of intermetallic compounds could be employed, but aluminium had the advantage of high temperature strength. If formability was a main requirement, however, the aluminium content would not have to exceed a few per cent. Some titanium alloys, such as those of titanium and aluminium, titanium-aluminium-carbon or titanium-aluminium-boron, cannot be heat-treated.

It has been known for some time that titanium is contaminated by air, and this has limited to some extent the temperatures at which it can be forged or rolled, and particularly the upper limits for fabrication. These limits were determined by trial and error, but it was decided to study the contamination behaviour of some titanium alloys when heated in air in order to determine with greater accuracy the upper temperature limits for fabrication. It was shown that the depth of contamination is a function of time and temperature. The method of studying the contamination was the utilization of the Van Ostrand—Dewey diffusion analysis of microhardness-penetration data. Equations were derived expressing depth of contamination in terms of a time-temperature parameter.

The alloys of titanium and sulphur had not been studied to any great extent, but it was decided to determine the effects of sulphur in sponge-base binary titanium-sulphur alloys. It was found that additions of up to 0·025% sulphur to titanium produced a greater tensile strength and lowered ductility. Further additions up to 0·45% did not have any marked effect on tensile strength. Sulphur has no effect on beta to alpha transformation temperatures. Small additions of sulphur efficiently refine the grain size of titanium and titanium alloys, in both the as-cast and as-wrought conditions.

The influence of sulphur on ductility is more important than hardness or strength. The ductility of sulphur-bearing titanium is dependent to a far greater extent on dispersion of sulphides than on the actual sulphur content. No difficulties are experienced in hot working alloys with up to 1·0% sulphur, but the upper limit of working has been found to be between 1015° and 1215° C.

Vanadium is a principal ingredient in a number of relatively new titanium alloys, and a study has been carried out of the variation in properties possible with beta titanium containing vanadium. These contained up to 24% vanadium. It was established that microstructural changes in these alloys resulting from variation in alloy content and heat treatment exerted a strong influence on strength and ductility. Increasing vanadium concentration in alloys consisting entirely of alpha phase developed higher strength and notch sensitivity, as well as lower ductility and impact resistance. Alloys with 11% vanadium in the quenched state had great ductility and showed exceptionally low ratio of yield strength to tensile strength. High levels of ductility and impact resistance were associated with the fully beta structures of quenched 20% and 24% vanadium alloys.

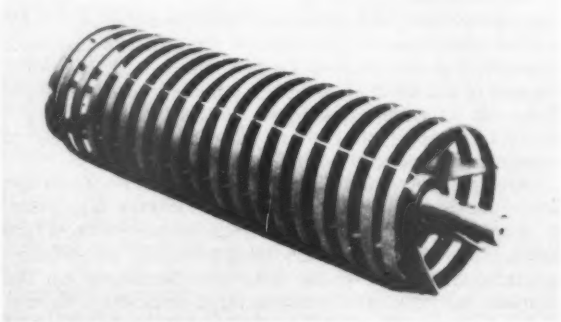
Alloys containing large quantities of retained beta phase produced good blends of strength and ductility when properly aged. Solution treatment in the alpha-beta region before ageing produced higher ductility at a given level of strength than did solution treatment in the beta region. The difference produced by the two types of solution treatment is associated with the original precipitation of alpha in the beta grain boundaries after solution treatment in the beta region.

An investigation has also been carried out to explain previously anomalous results obtained in studies of low temperature hydrogen absorption in the pickling of titanium. It has been suggested as a result that total hydrogen content is not necessarily a true criterion for expected mechanical behaviour, and distribution of the hydrogen should be considered. A material with a high hydrogen content, most of which is concentrated at the surface, may be acceptable if the thin surface layer can be eliminated by mechanical methods. In this connection it is suggested that acid-pickled titanium should not be heated after it has been descaled, as this may result in a deeper penetration of hydrogen.

Helical Conveyor Drum

Fabricated helical drums made by Whittington Engineering Company Limited, New Whittington, Chesterfield, are particularly suitable for all types of belt conveyors, and are supplied with either flat or crowned faces. Of strong construction in welded steel, they are practically unbreakable. The face is formed by a pair of steel strips helically wound towards one another with intervals between the convolutions of each. The vanes supporting the face are shaped from rolled steel plate, the thickness of which is proportionate to the required class of duty, and welded direct to a shaft (for driving drums), or to a tube containing bearings (for tension drums).

The advantages claimed for the Whittington drum are that it assists in keeping the belt centred on the drum face, as the opposing spirals formed by the strips act against one another when rotating, and it tends to clean the underside of the belt. Any size within wide limits can be made to meet special requirements, the minimum drum sizes being 7⅞ in. dia and 16½ in. face width.



The Whittington fabricated helical drum for belt conveyors

Wear Properties of Deep Anodized Coatings

Following a recent article in these pages on the subject of deep anodizing a number of requests were received for further details, particularly as regards wear-resistant properties. This article gives the results obtained by various methods of testing for wear, abrasion resistance, etc., and data on such loss of mechanical properties as result from deep anodizing

THE specific advantage offered by a deep anodized coating applied to suitable aluminium alloys is to produce a hard, wear-resistant surface which enables the material to be used for rubbing or bearing duties. In general, deep anodizing is restricted to alloys containing less than 5% copper, with coating thickness largely governed by the intended application of the component. For average applications a film thickness of 0·002 in. provides satisfactory abrasion resistant properties. Throwing power of the process is good so that it is possible to produce uniform coatings on irregular shapes and recessed areas, although control of the bath (particularly to avoid local overheating) can present difficult problems.

Assessment of the mechanical properties of the coating, particularly as regards wear and abrasion resistance, can only be made by comparative or specific tests. Surface hardness itself cannot be measured by standard instruments due to the fact that the coating is too thin and the indent too deep to yield reliable figures. It can be broadly classified as "file hard" and any subsequent finishing of coated parts must be done by grinding. This may become necessary in certain instances since the production of the coating results in some roughening of the surface finish and also a dimensional growth (the latter roughly proportional to the film thickness produced). The latter can, of course, be allowed for on the original dimensional tolerances for finishing prior to deep anodizing.

As a wear-resistant surface, deep anodized aluminium alloy is held to be comparable with—if not superior to—surface hardened carbon steels, hard chromium plate and high strength steel alloys. Mechanical strength of the component is, of course, limited to that of the basic metal and there are some losses of properties (see later). The main limitation is that a deep anodized component is not suitable for service conditions yielding high contact loads or impact loads where brinelling of the hard surface film can take place. Resistance to abrasion under light loads, however, is outstanding—also corrosion resistance to normal atmospheres and salt water, but the coating is attacked by strong acids and alkalies.

Typical comparative results as determined by the Martin Company employing a Taber Abrasion Tester using CS-17 rubber bonded abrasive wheels with a 1000 gram loading are summarized in Fig. 1. In this test, abrasion resistance is measured directly in terms of surface wear against the number of wear cycles. Performance of the deep anodized coating is seen to be remarkably good, and superior even to hard chrome plate and cyanide hardened mild steel, up to 100,000 cycles of abrasion.

Under normal sliding wear conditions the effect of lubricant can appreciably modify the performance of the hard coating, conventional lubricants generally giving an unsatisfactory performance or even a reduction in performance compared with the unlubricated condition. Lubricants such as molybdenum disulphide and graphite grease, on the other hand, tend generally to improve sliding wear resistance. Some typical experimental

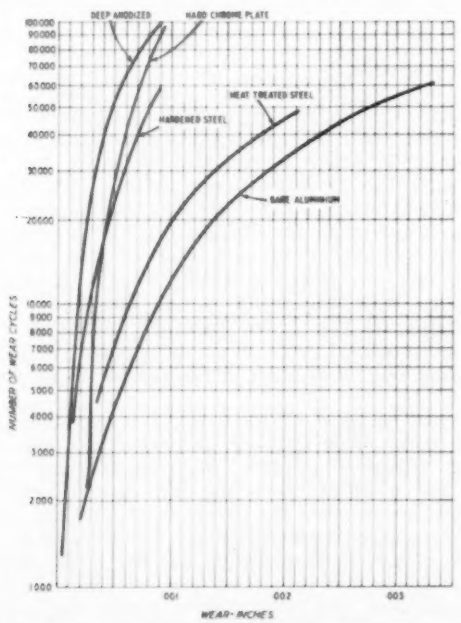


Fig. 1.—Wear rates of anodized alloy and other materials compared

Table I.—SLIDING SHOE TEST*

Surface	Sliding on	Lubricant	Wear condition after 10,000 cycles
75S–T6 Alumn.	75S–T6 Alumn.	none	Unsatisfactory
Mild steel	Mild steel	none	Fair
Mild steel	75S–T6 Alumn.	none	Unsatisfactory
Deep anodized 75S–T6	Yellow brass	none	V. good
" " "	Mild steel	none	V. good
" " "	Stainless steel	none	Fair
" " "	75S–T6 Alumn.	none	Fair
" " "	75S–T6 Alumn.	MoS_2 lubricant	Unsatisfactory
" " "	Deep anodized 75S–T6	none	Good
" " "	" " "	MoS_2 lubricant	Excellent
" " "	" " "	SAE 10 oil	Unsatisfactory
" " "	" " "	Petroleum jelly	Unsatisfactory
" " "	" " "	Graphite grease	Excellent
" " "	" " "	Water	V. good

*The Martin company

Table II.—ABRASIVE BLAST TEST*

Coating	On	Thickness	Weight of abrasive to break through (gram)
Deep anodized	6061–T6	·002 in.	180
Deep anodized	7075–T6	·002 in.	175
Deep anodized	7075–T6	·004 in.	348
Chromic acid anodized	6061–T6	—	2·5

*The Martin Company

Table III.—STIRRUP AND PIVOT TESTS*

Joint	Bearing Materials	Cycles of test	Bearing wear	Bearing condition
			in.	
Foot	Alumilite† *v.* Alumilite	3,000,000	0·008	Fair
Ankle	,, ,,	3,000,000	0·040	Poor
,,	,, ,,	1,069,000	0·012	Poor
,,	,, ,,	1,065,000	0·018	Poor
,,	Nylon *v.* Nylon	1,000,000	0·0025–0·006	V. good—Fair
Foot	Alumilite *v.* Alumilite	3,000,000	0·003 –0·009	Good—Fair
Free	Alumilite *v.* Alumilite	3,000,000	0·0123	Fair
Ankle	Oilite *v.* Stainless Steel	3,000,000	0·0047	Good
,,	Alumilite *v.* Alumilite	3,000,000	0·048	Poor
,,	Oilite *v.* Stainless Steel	1,000,000	0·005	Good
,,	Nylon *v.* Nylon	1,000,000 (oscillating)	0·0035	Good
,,	Deep Anodized *v.* Deep Anodized	2,140,000	0·001	V. Good
,,	,, ,, ,, ,,	1,082,750	Not measurable	Excellent
,,	,, ,, ,, ,,	2,158,000	Less than ·001	Excellent
,,	,, ,, ,, ,,	1,000,000 (oscillating)	0·001	Excellent

*Catranis Laboratory, U.S.A. †Alumilite refers to sulphuric acid anodized aluminium alloy.

results are summarized in Table I, corresponding to wear produced by a sliding shoe of 1 sq in. surface area loaded with 5 lb weight and operating with a stroke of 3 in. Each combination of sliding surfaces investigated was subjected to 10,000 wear cycles and the surfaces then examined to establish the wear condition.

A further series of tests, also conducted by the Martin Company, consisted of directing an abrasive blast against the surface, the abrasive used being 180 mesh silicon carbide projected against the surface with 15 oz air pressure. Surfaces were evaluated against abrasive wear on the basis of the weight of abrasive, in grams, required to break through the coating. Results are detailed in Table II. As would be expected, abrasion resistance is directly proportional to the coating thickness.

Numerous service tests have been made with deep anodized components which generally confirm laboratory results. A particularly interesting series of such tests was conducted with sample leg brace parts for artificial limbs, consisting of pivots and stirrups, under the supervision of the Advisory Committee on Artificial Limbs for the (American) National Research Council. Conventional bearing materials were evaluated together with 0·0004 in., 0·0008 in. and 0·002 in. deep anodized coatings on aluminium alloy. Accelerated wear conditions were established by applying a constant load of 100 lb to the joints and the stirrups swung through an arc of 35° at a speed of 172 cycles per minute. Complete results are summarized in Table III.

From these data it was evident that for plain (unbushed) bearings a deep anodized coating rubbing on a deep anodized coating gave the best performance; and with bushed type bearings a deep anodized finish in contact with nylon bushings proved superior. It was also estimated that a normal wear resistance coating of conventional thickness (0·002 in.), with properly fitted parts, should be good for a life of between one and two

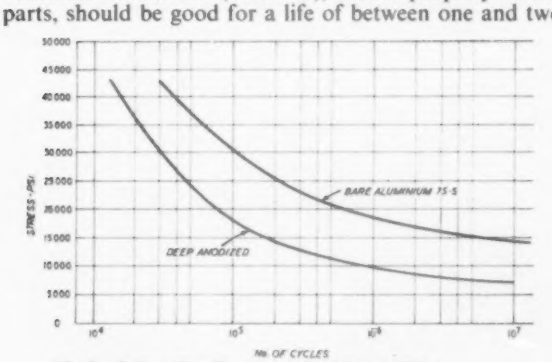


Fig. 2.—Fatigue life suffers as a result of deep anodizing

Table IV.—MECHANICAL PROPERTIES*
(0·065 in. 75S—T6 SHEET)

Condition	Yield strength	Ultimate strength
	psi	psi
Uncoated, untreated	75,000	83,000
Chromic acid anodized	74,940	83,140
Sulphuric acid anodized	74,350	83,050
Deep anodized 0·0004 in. film	73,730	82,470
0·0008 in. film	72,010	81,910
0·0020 in. film	70,700	80,470

*The Martin Company

Table V.—LOSS OF DUCTILITY*
(0·065 in. 75S—T6 SHEET)

Condition	Elongation % on 2 in.
Uncoated, untreated	11·3
Chromic acid anodized	11·3
Sulphuric acid anodized	11·0
Deep anodized 0·004 in. film	9·5
0·008 in. film	8·8
0·020 in. film	7·8

*The Martin Company

million cycles before the case wore through. Measurement of wear rate under an oscillating load also indicated that the wear on deep anodized surfaces was only very slightly greater than 0·001 in. per million cycles, as compared with 0·0035 in. per million cycles for nylon on nylon; and 0·006 in. per million cycles for alumilite on alumilite.

Loss of properties

Loss of properties with deep anodized coatings is not necessarily serious. In the main these comprise a very slight reduction in yield strength and ultimate strength, see Table IV, which is virtually negligible, but some appreciable loss of ductility, see Table V. The latter is only likely to be significant where the treated component is reworked, restricting, for example, permissible bend radii.

Fatigue life also suffers as a result of deep anodizing. This, in fact, is a general condition when a hard coating is applied over any softer metal. The loss is quite appreciable, see Fig. 2, and materially affects the maximum permissible stress of a component subject to oscillating loading or other service conditions promoting fatigue.

Thermal stability of the coating is generally good with freedom from spalling, although there may be a definite tendency towards checking at temperatures above 200° F. This is due to the difference in coefficients of expansion between the parent metal and the surface film. The coated component is not, however, limited to a maximum service temperature of 200° F as although some checking may occur this does not affect the corrosion resistance and only slightly lowers the abrasion resistance of the coating.

Chromium—the Modern Metal

Chromium is a bluish-white metal capable of taking a high polish, and having an extremely high melting point combined with great chemical activity at high temperatures. It has become a most important alloying element in many modern steels and metals. Notes are given on recent researches into its uses and effects

THE first studies of the sheet textures of body-centred cubic metals were mainly related to the ferrous metals. Within the last six years the cold-rolled texture of another such metal, chromium, has been investigated. This is reported to be mainly {100} <011> with some evidence of the {111} <112> orientation. A determination for recrystallized chromium showed no preferred orientation.

Conflicting data have been put forward concerning the effect of composition upon the embrittlement of 12% chromium steels at a temperature of about 470° C. Attention has been concentrated mainly on a steel containing 0·1% to 0·3% aluminium. A particularly valuable use of 12% chromium steel lies in linings for vessels used at elevated temperatures in oil refineries and other chemical industries. Here the resistance of the steel to corrosion is sufficient and the steels are less embrittled than the 17% chromium steels formerly used. Because of the way in which they are formed, these vessels are made from annealed material and therefore an investigation was carried out into the embrittling behaviour or shift in transition temperature of annealed steels of the 12% type in different compositions heated for a protracted period of time at about 480° C. The results are as follows:

No serious increase of transition temperature was observed after ageing for 10,000 hr. The 0·25% aluminium does not promote increased transition temperature after ageing. Low transition temperatures for both annealed and aged states were obtained. Adding 0·5% molybdenum to high and low chromium and chromium aluminium steels of the 12% chromium type produced an intermediate transition temperature range for annealed steels. After ageing, the low chromium molybdenum steel increased in transition temperature, but the high chromium-molybdenum and the low chromium-aluminium-molybdenum steels did not.

Adding molybdenum and aluminium eliminated the embrittlement. Adding 0·1% titanium to the chromium aluminium steels did not consistently lower transition temperatures. Sigma phase appeared in some of the steels after cold reduction and ageing. Impact data obtained suggested that for commercial work involving long service at elevated temperatures, where no increase in transition temperature could be tolerated, a 12% chromium-aluminium-molybdenum steel should be used. For cold conditions or brief service at elevated temperatures, where low transition temperatures are of major importance, low chromium (about 12%) chromium-aluminium steel has advantages.

Knowledge of the influence of metallurgical variables on high temperature properties is needed for the correct design of metal parts for use at elevated temperatures. Particularly, research was needed into the effect of cold deformation on the variation of strength with time at elevated temperatures in connection with steel bolts for aircraft engines. Consequently, research was embarked upon into the effect of previous cold deformation on the high temperature strength of a chromium molybdenum steel. The results are as follows.

Cold work effect depends on the temperature and the degree of deformation. Creep strength and rupture strength increase as cold work increases at 370° C. These properties are reduced by small amounts of cold work, but improved by 30% hot work. Cold work is less effective at 480° C in tests of 1000 hr duration. At 540° C cold work does not affect rupture strength, but reduces creep strength as the degree of cold work increases. Other data of industrial value were obtained.

The effects of changes of composition on tensile strength, transverse reduction of area, and transverse impact quality, of chromium steels has been investigated. The facts obtained suggest that chromium affects transverse ductility of a quenched and tempered steel in only a minor degree. Additional chromium does not appear to affect transverse toughness to any appreciable degree. Any improvement of transverse ductility resulting from an increase of chromium content is not important. Chromium seems to give a higher strength at a specific tempering temperature because of increases in tempering resistance. Increased chromium made no appreciable difference to reduction of area or transverse impact values of the steel when fully hardened and tempered.

The ferritic chromium stainless steels are liable to be corroded by intergranular attack. Little is known regarding the conditions rendering the steels susceptible to this form of attack and the mechanism responsible. Investigation was undertaken and revealed that steel with a chromium content of from 16% to about 25% exercized little effect on intergranular corrosion in steels within this chromium range after they had been welded.

Some phenomena discovered during an investigation of 21% chromium, 12% nickel steels, used for special exhaust valves, revealed certain results that were not anticipated and could not be explained. In consequence, further research was embarked upon to account for the hardening produced in high carbon austentic steels of this type. Increase of phosphorus raised the rates of precipitation, precipitation hardening, and overageing in this type of steel. It also increased the degree of dispersion of the precipitate formed in the steels. No evidence could be found for the formation of a phosphorus compound, and therefore an alternative mechanism was suggested to explain the effects of the phosphorus, based on increased strain energy of the austenite lattice of the steels owing to interstitially dissolved phosphorus.

A comprehensive study of the chromium nickel manganese steels containing nitrogen has been made with the

CHAIN GRATE STOKER.—The Bennis Mark V chain grate stoker introduced by Bennis Combustion Limited, Little Hulton, Walkden, Manchester has been designed for applications where high burning rates are required. It incorporates a new thin link giving the high air to metal ratio necessary for efficient combustion and cooling the grate under these conditions. A system of internal baffles replaces the integrater damper, simplifying operation and regulating accurately the air supply to all sections of the grate

object of determining the range of composition giving the best properties, including resistance to corrosion. The steels investigated contained 12% to 18% chromium, 1% to 22% manganese and 0% to 14% nickel, with 0·12% to 0·18% nitrogen. These proved to have properties comparable to those of the 18-8 chromium nickel stainless steels. The best composition range was found to be 16% to 17·5% chromium, 3·4% to 4·5% nickel, 7% to 9% manganese, 0·06% to 0·12% carbon, and 0·12% to 0·18% nitrogen.

Many researches have indicated the creep strength of low alloy steel to be sensitive to the method of heat treatment. An investigation was initiated some years ago to discover the effect of a number of variables in heat-treatment on the stress rupture strength, creep embrittlement and notch sensitivity for a chromium molybdenum vanadium and a steel containing 17% chromium, 4% nickel and 4% copper. The variables were concerned with the normalizing and tempering temperatures and the tempering time. It was indicated as a result that the notch sensitivity and smooth ductility for both types of alloy were much affected by the heat treatment. High normalizing temperatures impaired the ductility and notch strength of the chromium molybdenum vanadium steel considerably. Higher tempering temperatures reduced notch sensitivity and caused a decline in smooth strength. Various other data were obtained, all being a valuable contribution to the solution of problems concerning embrittlement in metals.

Of recent years there has been great interest in the development of wrought chromium as an engineering material, especially for use at high temperatures. Small ingots have been formed into wire and sheet Chromium is certainly ductile at elevated temperatures, but lacks room temperature ductility because it shows a transition from ductile to brittle behaviour on cooling, this transition usually occurring at about 50° C. The embrittlement is so great that the metal will not tolerate plastic deformation.

An effort has therefore been made to determine the basic mechanical properties of forged chromium using high purity qualities of metal. The results are said to be encouraging enough to show that a room temperature ductile chromium may be obtained without recourse to ultra-purification processes. The key to the successful forging of cast chromium appears to be the strain rate. Refinement of the recrystallized grain size can lower the transition temperature.

Further research was also carried out into the tensile and stress-rupture properties of chromium, so that a basis could be established for the comparison of this metal with other refractory alloy bases. No yield points were observed, but some evidence of strain ageing at intermediate temperatures was obtained. Both tensile and stress-rupture properties were lower than those of molybdenum and tungsten. The difference in properties is related closely to melting point difference.

The general result of these researches into chromium base alloys ductile at room temperature seems to be that a second element must be added to raise the brittle to ductile transition temperature. Room temperature ductile chromium alloys can be obtained if the transition temperature of the starting chromium is low enough, and such alloys fall within the range 60% to 90% chromium.

Flexiroll Troughing Idlers

Flexiroll troughing idler conveyors with 30-in. wide belts have been installed in the No. 1 and No. 2 "panels" of the south-east section of the six feet seam at Brynlliw Colliery, South Wales. Their loads are discharged on to a third Flexiroll conveyor with a 36-in. wide belt running at right angles down the main gate road to a station on the main east intake, where the coal is loaded on to the underground loco system.

Flexiroll was primarily designed as a fireproof conveyor, with no metal to metal contact, so that friction likely to cause over-heating is reduced to a minimum. The moulded plastic rollers are mounted on semi-elliptical spring steel spindles, providing a shallow trough for light loads and becoming deeper as the load increases. Nylon bearings are used throughout, dispensing with the need for lubrication and a minimum of maintenance is necessary. The PVC belt is doubly insulated from impact and "pinch" by the cushioning effect of the supporting rollers and the flexibility of the spring steel mounting. Extensions can be carried out quickly and easily without special tools. The manufacturers are Fisher and Ludlow Limited, P.O. Box 12, Tipton, Staffs.

The Flexiroll troughing idler conveyor

Nuclear Energy: 1959-60

A chronological survey of the principal events in research and development

By J. R. FINNICOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

1960

December

The second of the U.S. Navy's new long range Polaris missiles (A2) was successfully launched on a 1,600 miles test flight at Cape Canaveral, Florida, covering the distance in about 15 minutes.

France adopted a five year programme to create an independent nuclear striking force at a cost of £870 million, half of which will be used for the nuclear force.

At a symposium on the Dounreay Fast Reactor presented at the British Nuclear Energy Conference in London six papers were submitted for discussion. The fast reactor, in which the neutrons emitted when nuclear fission takes place are not slowed down by a moderator as in the graphite reactor, was first conceived in 1951. It uses enriched uranium U235 or plutonium Pu239 as fuel in the core surrounded by a thick blanket of ordinary uranium, U238, or thorium, Th232, as fertile material in which new fuel will be bred. The chief ore of thorium is monazite, a yellow-brown sand found in North Carolina, Brazil, Ceylon and Southern India. A fast or breeder reactor produces more nuclear fuel than it consumes while operating to generate useful power. Such a reactor converts U238 into fissionable U235 or Th232 into fissional U233, thus converting non-fissional elements into fuel. In February, 1954, the zero energy fast reactor " ZEPHYR" was in operation for conducting fast reactor studies, primarily concerned with the breeding characteristics of the plutonium-uranium system and the nuclear properties of many materials in fast reactors. The results revealed that the reactor produced about twice as much fuel as it consumed, this ratio being obtained in the ideal condition of a small uncooled system. On the 14th November, 1959 the fast reactor became critical and was run at low power (100 watts) but at high temperature. However, some trouble was experienced as the result of the formation of oxides in the coolant, consisting of sodium and potassium alloy, the total being 120 ton. Improvements were made to the oxide clean-up circuits. The initial experience during the start-up confirmed the potentialities of this reactor system. At the conclusion of these tests the reactor was shut down for a pre-arranged modification to the core, so that other, more advanced, types of fast reactor fuel elements could be tested. The reactor

Table V.—PARTICULARS OF THE U.K.A.E.A.'S EXPERIMENTAL FAST REACTORS AT HARWELL AND DOUNREAY

1	2	3	4	5
Item		ZEPHYR (Harwell)	ZEUS (Harwell)	DOUNREAY (near Thurso)
1	Date of start up	Feb. 1954	22nd Dec.1955	14th Nov. 1959
2	Maximum thermal output	few watts	100 watts	60 MW
3	Maximum electrical output	nil	nil	15 MW
4	Fuel	plutonium Pu 239	uranium U 235	enriched uranium U 235 or plutonium Pu239
5	Moderator	none	none	none
6	Coolant	none	none	liquid metal (sodium-potassium alloy, 70/30 by weight)
7	Purpose	fast reactor studies	studying a particular core design for the Dounreay fast reactor	fast reactor breeding studies

Table VI.—A SUMMARY OF THE ESSENTIAL PARTICULARS OF U.K.A.E.A'S FAST REACTOR AT DOUNREAY, NEAR THURSO, CAITHNESS. GENERAL, REACTOR CORE, BREEDER BLANKET AND FUEL ELEMENTS

1	Progress dates	
	(a) Project first considered	1952
	(b) Design study commenced	1953
	(c) Project authorized	March, 1954
	(d) Work started on site	March, 1956
	(e) Prototype production of fuel elements	July, 1957
	(f) Achieved criticality	14th Nov., 1959
2	Type of reactor	
	(a) Fuel: core	45% enriched uranium U235 (produced by the gaseous diffusion plan at Capenhurst, Cheshire)
	breeder blanket	natural uranium U238
	(b) Coolant	liquid sodium-potassium alloy, 70/30 by weight
3	General	
	(a) Number of reactors	1
	(b) Number of primary heat exchangers	24
	(c) Number of secondary heat exchangers	12
	(d) Number of steam raising plants (including secondary heat exchangers, steam drum and dump condensers)	12
	(e) Number of coolant loops per reactor	24
	(f) Number of turbogenerators	1
	(g) Number of condensing and feed heating plants	1
4	Ratings	
	(a) Thermal rating of core	60 MW
	(b) Thermal rating of breeder blanket	12 MW
	(c) Total thermal rating (a + b)	72 MW
	(d) Maximum rating of turbogenerator	15 MW
	(e) Station thermal efficiency	25%
5	Reactor core	
	(a) Shape	hexagonal
	(b) Dimensions: across flats	21 in.
	length	21 in.
	(c) Composition in % of volume	
	U235	9·3%
	U238	22·7%
	Niobium (Nb)	5·5%
	Vanadium (Va)	1·9%
	Stainless steel	19·1%
	Coolant	41·5%
6	Breeder blanket	
	(a) Dimensions: diameter	74·6 in.
	length	84·0 in.
	(b) Composition in % of volume	
	U235	0·4%
	U238	60·1%
	Stainless steel	9·5%
	Coolant	30·0%
7	Fuel elements for the core	
	(a) Type of fuel	45% enriched uranium U235 alloyed with 0·5% atomic chromium
	(b) Number of fuel elements	367
	(c) Number of pieces for each fuel element	7
	(d) Total number of pieces	2569
	(e) Dimensions	
	Fuel: diameter (i.s.)	0·316 in.
	diameter (o.s.)	0·698 in.
	Inner tube: diameter (i.s.)	0·258 in.
	diameter (o.s.)	0·298 in.
	thickness	0·020 in.
	Outer tube: diameter (i.s.)	0·712 in.
	diameter (o.s.)	0·752 in.
	thickness	0·020 in.
	(f) Materials	
	Inner tube	vanadium
	Outer tube (with integral finning along part of its length)	niobium
	(g) Temperatures (maximum)	
	Uranium	840° C (1544° F)
	Inner tube	680° C (1256° F)
	Outer tube	550° C (1022° F)
8	Fuel elements for breeder blanket	
	(a) Type of fuel	natural uranium U238
	(b) Number of fuel elements	1872
	(c) Dimensions of fuel elements: diameter	1½ in.
	length	8 ft.
	(d) Thickness of cladding (stainless steel)	0·030 in.
	(e) Heat transfer surface	4420 sq ft
	(f) Heat flux (average)	5150 Chu/h/sq

Table VII.—A SUMMARY OF THE ESSENTIAL PARTICULARS OF U.K.A.E.A'S FAST REACTOR AT DOUNREAY, NEAR THURSO, CAITHNESS. REACTOR VESSEL AND COOLANT FOR THE CORE AND BREEDER BLANKET

1	Reactor vessel (contains the core, breeder assemblies and the control mechanism	
	(a) Type and shape	double-walled cylindrical outer shell with domed bottom and flat top
	(b) Thickness of double walls	¾ in. and ½ in.
	(c) Gap between walls (gas filled for leak detection system)	¼ in.
	(f) Number of inlet pipes for the coolant (total)	24
	(g) Number of outlet pipes for the coolant core	20
	breeder	4
	total	24
	(h) Dimensions	
	Inside diameter	10 ft 6 in.
	Outside diameter	14 ft
	Thickness	1½ in.
	Height	20 ft
	(i) Design conditions for the main shell	
	Specification	B.S. 1500:1949
	Pressure	50 psi
	Inlet temperature	200° C (392° F)
	Outlet temperature	400° C (752° F)
	Difference in temperature	200° C (360° F)
	(j) Material	18/8/1 stainless
	(k) Weight	45 ton
2	Reactor vessel support system	
	(a) Number of sets of columns	2
	(b) Number of columns per each set	24
	(c) Pitch circle of inner columns	12 ft
	(d) Pitch circle of outer columns	21 ft 6 in.
	(e) Height of the columns	32 ft
	(f) Height at which the two set of columns are interconnected	11 ft
3	Coolant for the core	
	(a) Type of liquid (melting point — 45° C (113° F)	an alloy of sodium and potassium (70/30 by weight)
	(b) Rate of flow	584 lb/sec
	(c) Flow area	0·694 sq ft
	(d) Velocity of coolant	15·8 ft
	(e) Pressure drop across core	11·0 psi
	(f) Inlet temperature of coolant	200° C (392° F)
	(g) Outlet temperature of coolant	400° C (752° F)
	(h) Rise in temperature of coolant	200° C (360° F)
	(i) Direction of flow of coolant	downwards
4	Coolant for the breeder blanket	
	(a) Type of liquid	an alloy of sodium and potassium (70/30 by weight)
	(b) Rate of flow	156 lb/sec
	(c) Flow area	8·1 sq ft
	(d) Velocity of coolant	0·5 ft/sec
	(e) Inlet temperature of coolant	200° C (392° F)
	(f) Outlet temperature of coolant	350° C (662° F)
	(g) Rise in temperature of coolant	150° C (270° F)
	(i) Direction of flow of coolant	downwards

Table VIII.—A SUMMARY OF THE ESSENTIAL PARTICULARS OF U.K.A.E.A'S FAST REACTOR AT DOUNREAY, NEAR THURSO, CAITHNESS. HEAT EXCHANGERS, CIRCULATING PUMPS, STEAM DRUMS AND DUMP CONDENSERS

1	Primary heat exchangers (liquid metal to liquid metal)	
	(a) Number of heat exchangers (arranged in banks surrounding the reactor vessel and within the containment sphere)	24
	(b) Type	concentric tubes spaced by spiders
	(c) Coolant for the primary and secondary circuits	sodium-potassium alloy (70/30 by weight)
	(d) Primary circuit	inner tubes
	(e) Secondary circuit	outer tubes
	(f) Heat transfer duty of each primary heat exchanger	3 MW
	(g) Heat transfer of the 24 primary heat exchangers	72 MW
	(h) Diameter of inner tube	4 in.
	(i) Diameter of outer tube	6 in.
	(j) Length of concentric tube for each heat exchanger, formed into 7 loops	300 ft
	(k) The two cooling circuits are arranged for	contra flow
	(l) Primary coolant flow rate	866·7 lb/sec
	(m) Secondary coolant flow rate	866·7 lb/sec
	(n) Inlet temperature of primary coolant	400° C (742° F)
	(o) Outlet temperature of primary coolant	200° C (392° F)
	(p) Temperature drop of primary coolant	200° C (360° F)
	(q) Inlet temperature of secondary coolant	175° C (347° F)
	(r) Outlet temperature of secondary coolant	325° C (617° F)
	(s) Temperature rise of secondary coolant	150° C (270° F)
2	Secondary heat exchanger (liquid metal to water)	
	(a) Number of units	12
	(b) Type	copper-bonded parallel tubes
	(c) Number of assemblies for each heat exchanger	21
	(d) Number of elements for each assembly	13
	(e) Type of element	one water tube surrounded by four liquid metal tubes mounted in close-packed copper laminations
	(f) Material of tubes carrying liquid metal and the water	stainless steel
	(g) Method of welding the 3000 welds	Argon arc process
	(h) Steam pressure	200 psi
	(i) Steam temperature	274° C (525·2° F)
	(j) Feed temperature	194° C (381·2° F)
	(k) Steam flow	204,000 lb/hr
3	Circulating pumps for liquid sodium-potassium circuits	
	(a) Type of pump: electromagnetic flat linear d.c. induction with flat pump tubes welded to pumping circuit	
	(b) Number of primary pumps	24
	(c) Number of secondary pumps	24
	(d) Inlet pressure	12 psi
	(e) Pressure rise across pump (pressure drop in core 11 psi + in circuit 13 psi)	24 psi
	(f) Efficiency of the pump	24%
	(g) Power consumed of four pumps (2 primary + 2 secondary)	120 kW
4	Steam raising drum	
	(a) Number	12
	(b) Dimensions	4 ft 6 in. dia—4 ft long
5	Number of dump condensers to absorb full reactor heat output if turbine is not running	12

is designed for a maximum thermal rating of 60 MW and an electrical output of 15 MW. The present core of enriched uranium in the form of 360 rods making up a prism 21 in. high and the same distance across will eventually be replaced by one made of plutonium. Particulars of the U.K.A.E.A's experimental fast reactors are indicated in Table V. A summary of the essential information and the design data is presented in greater detail in Tables VI, VII, VIII and IX.

The C.E.G.B. applied for permission to construct a nuclear power station with a generating capacity not exceeding 800 MW at Wylfa, North Wales.

The Swiss Federal Government decided to support financially only one of three nuclear power plant projects resulting in the formation of a new group to be known as the "National Company". The Federal Government will provide SwF 70 million (£5·83 million) for the project which is based on the proposals previously prepared by Thermatom for a 30 MW (thermal) natural uranium, heavy water moderated and cooled, pressurized tube type reactor of entirely Swiss design to be built on ENUSA site at Lucens, near Lausanne.

The United States and Canada joined as full members, the Organization of Economic Co-operation and Development (O.E.C.D.) which replaces O.E.E.C.

The United States offered tentatively to the North Atlantic Treaty Organization, before the end of 1963, a naval force of five nuclear-powered submarines each carrying 16 Polaris missiles.

A fire in the U.S. Navy's largest missile-carrying attack aircraft carrier "Constellation" at Brooklyn naval dockyard, New York resulted in 50 deaths and damage amounting to £27 million. The "Constellation" scheduled for completion in March, 1961, is the last of the six aircraft carriers of the "Forrestal" class.

Treaties were signed between West Germany and Euratom for the establishment of a European institute at Karlsruhe for the study of the peaceful uses of radioactive elements heavier than uranium.

Table IX.—A SUMMARY OF THE ESSENTIAL PARTICULARS OF U.K.A.E.A'S FAST REACTOR AT DOUNREAY, NEAR THURSO, CAITHNESS. CONTROL RODS, BIOLOGICAL SHIELD, CONTAINMENT VESSEL, TURBO-GENERATOR SET, DIESEL DRIVEN GENERATORS AND PUMPS AND CRANE

1 Control rods	
(a) Number of groups	12
(b) Number of control rods for each group	10
(c) Total number of control rods	120
(d) Number of control rod for shut down	6
(e) Number of safety control rods	2
(f) Reactivity controlled by each group	
Control	3·6%
Shut off	2·4%
Safety	1·2%
2 Biological shield	
(a) Material	concrete
(b) Specific weight of concrete	145 lb/cu ft
(c) Shape	form of a bowl
(d) Diameter (inside)	90 ft
(e) Height	45 ft
(f) Thickness of wall	5 ft
(g) Temperature at which the concrete is maintained by air cooling through a gap between 3 in. thick lagging and the concrete	less than 50° C (122° F)
3 Containment vessel (houses the reactor, the primary heat exchangers and the biological shield)	
(a) Shape	sphere
(b) Diameter	135 ft
(c) Designed internal pressure	18 psi
(d) Material (thick plates made of Coltuf 28, the thinner plates to Lloyds P403 specification and the particularly highly stressed plate round the base of the sphere of Coltuf 32)	mild steel
(e) Thickness of material	1 in. and 1¼ in.
(f) Total length of welded seams (These have all been radiographically inspected)	2 miles
(g) Access to the sphere through a lock with air tight doors	
Diameter	16 ft
length	40 ft
4 Turbogenerator set	
(a) Rating	15 MW
(b) Speed	3000 rpm
(c) Voltage of generator	11 kV
(d) Power factor	0·85
(e) Type of turbine	axial flow, condensing
(f) Steam conditions at the turbine stop valve	150 psig
Temperature	518° F
(g) Number of steam chests (arranged symmetrically to the set)	2
(h) Steam admission to cylinder	top and bottom
(i) Diameter of supplying steam to each chest	12 in.
(j) Number of emergency valves for each chest	1
(k) Number of single beat governor valves for each chest	3
(l) Method of governing	nozzle control
(m) Pressure and vacuum unloading device	yes
(n) Final feed temperature	325° F
5 Diesel driven generators	
(a) Number of sets supplying electric power to all the circulating pumps and the equipment in the main reactor cooling circuits	12
(b) Number of stand-by sets for (a)	6
(c) Total number of sets (a) + (b)	18
(d) Rating of each set	120 kW
(f) Voltage of each set	415 volt
(h) Number of cycles	50 c/secs
(g) Rating of stand-by generators for auxiliaries of the reactor plant in the event of failure of the National grid	220 kW
6 Diesel driven pumps	
(a) Number used for the circulation pumps, supplying sea water for cooling the main condenser of 15 MW turbine and also for cooling the auxiliaries of the steam raising plants	4
7 Rotating gantry crane used for handling the reactor charging and discharging machine	
(a) Length	115 ft
(b) Height	50 ft
(c) Pitch of circular track	83 ft
(d) Lift of large hook	25 ton
(e) Lift of small hook	7½ ton

The report "The Hazards to Man of Nuclear and Allied Radiations" was published by H.M.S.O.

The nuclear-powered U.S. submarine "Robert E. Lee" fired successfully a Polaris missile while submerged 90 ft beneath the Atlantic, 30 miles off Cape Canaveral.

A Transatom, an information centre for translations of nuclear literature was established at the Euratom headquarters, Brussels.

Lloyd's Register of Shipping published provisional rules for the design of nuclear-powered merchant ships, based on a number of years' experience in the surveying of land-based nuclear plants.

France exploded her third atomic bomb at Reggan, in Algeria, in the centre of the Sahara, about 935 miles south of Oran. It has been stated that the bomb had an explosive power of several kiloton, where a kiloton is equal to 1000 tons of T.N.T.

An American physicist stated that the United States has a stockpile equal to about 50,000 atom bombs of the type dropped on Hiroshima and in another three years she will have the equivalent of an additional 30,000.

A nuclear-powered U.S. submarine with her tubes filled with Polaris missiles, set out for the Atlantic on a three months underwater patrol.

(*concluded*)

Fabric Bearings for Atomic Power Stations

United Coke and Chemicals Company Limited, Orgreave, Handsworth, Sheffield 13, have added to their range of Orkot resin-bonded fabrics, Orkot Grade TL, which has undergone extensive radiation exposure and aqueous immersion tests and has been specified for the bearings for the fuel element handling equipment at both Hinkley Point and Sizewell atomic power stations.

The new material is tough, hard wearing and has a low coefficient of friction with aqueous lubricants. For dry running conditions, it is available impregnated with graphite or MoS_2. It is dimensionally stable in the presence of water and has a remarkably high resistance to radiation damage. Other mechanical properties are: compressive strength (flatwise) 49,000 psi; compressive strength (edgewise) 15,000 psi; impact strength 20 ft/lb/in. flexural strength 10,500 psi; flexural modulus $0{\cdot}5 \times 10^6$ psi.

Cable Repairing Strip

A new and improved type of unvulcanised PCP (Polychloroprene) strip, with a shelf-life of six months, improved "tooling-in" properties and a reduced curing time, has been introduced by Cable Division of Associated Electrical Industries Limited, 145 Charing Cross Road, London WC2. The improved strip, used for repairing the sheathing of PCP-sheathed cables, will sell at the same price as types previously offered by AEI and is available in roll widths of 1, 1½ and 2 in. Because of its greater elasticity, the new strip is approximately 0·05 in. thick against the 0·018 in. of the old type. It is supplied in black only.

Lathe Carrier

A new lathe carrier designed by Ratby Engineering Company Limited, Leicester, one of the Lindustries group of companies, is self-contained and has an eight point clamping arrangement. To attach the carrier to the component it is only necessary to place it over the end of the part and close the locking lever; removing is just as quick. The carrier is supplied in 3 sizes, types A, B and C which cover a wide variety of bar sizes, ranging from ¼ in. to 1¼ in. dia.

Production Practice:

Special Holding and Centralizing Jaws
Spring Lifting Hook
Machining Thin Wall Tubes

By JOHN WALLER

THE centralization of a circular component is often required and too frequently the tool designer merely provides a moving jaw to perform the function of clamping and a fixed but adjustable jaw as for locating; the idea being that an average component is taken and the latter jaw is adjusted and finally clamped in position. The work then proceeds often with a high percentage of scrap due to the fact that drilling or perhaps milling is not central with some prominent feature on the component and the unsightly appearance would make it virtually unsaleable.

The provision of special holding jaws is essential to overcome this problem. Admittedly the equipment is considerably more elaborate but in view of the elimination of scrap the device will soon repay the extra expenditure and properly covered over to prevent swarf and chippings entering the mechanism it will give long service without attention.

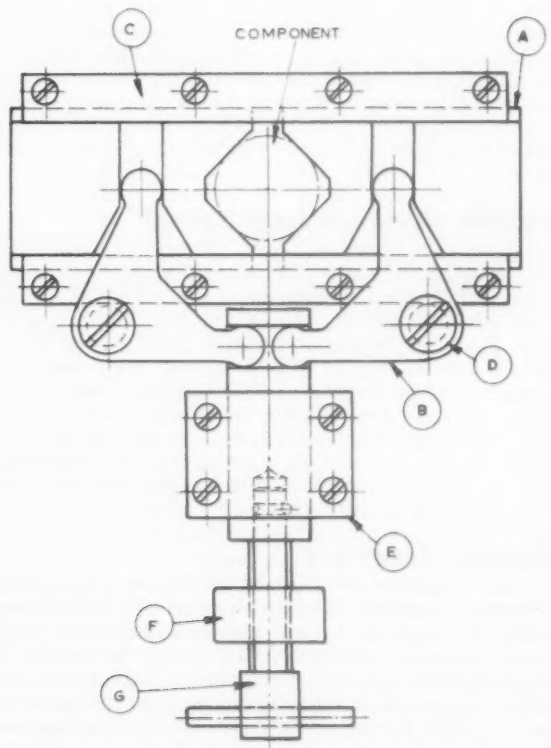


Fig. 1.—Sliding jaw type equipment for centralizing circular or hexagon bar material

Fig. 1 illustrates two bell crank levers B each having radial ends. The parts incidentally, are flat pieces of plate, and these are held in position by the shouldered screws D; they can rotate freely but not lift. The jaws engaging with these levers are slotted as shown with one portion machined away to permit the lever to swing without interfering with the jaw, while the opposite end engages in another slot milled in the block that forms part of the assembly at E. The clamping screw G which passes through the pillar or part of the jig at F completes the arrangement; the only other point of note being, of course, the tee slot in which the clamping jaws slide.

The method of operation is fairly obvious from the drawing. The movement forward of the screw causes the block at E to slide and so make the bell crank levers rotate about the shouldered screws D; an action that would make the jaws open. Thus as the normal action of advancing the screw when the latter is turned is in a right-hand direction, and the fact that this direction is the accepted one for clamping, the substitution of a left-handed thread is essential.

Case-hardening is required on the holding surfaces of the jaws and the slot for the bell crank lever; while the latter also requires hardening on the radial portions. The slot in the slider and the jaw both need similar treatment.

As both jaws move in unison, they must grip a circular component and move it to the exact position needed for machining. The positioning of the drill or tool is then a matter of accurate setting in relation to them, but the chief factor is that both members move together and not, as previously, one jaw stationary while the other performs the work of positioning and clamping.

The type of hook shown in Fig. 2 is useful when handling components with a hoist. Two flat plates A and B are drilled in each corner for the long studs C which are of high carbon steel to resist stretching. Into one of these plates is fitted a hook D, and though this is riveted over, resort is also made to welding to ensure that it cannot pull away under load.

Inside the assembly is the moving hook holder E, a circular piece of steel that also does duty in providing a seating for one end of the coiled spring, the opposite end bearing against plate B. Into this is threaded the moving hook F—a rather coarse thread is suggested and as the part E can rotate, the end of this hook is also riveted over. Alternatively a drilled and countersunk hole with welding is used.

The size of the spring depends on the weight of the components being lifted, but some latitude is possible as the degree of pressure exerted by an operator in an

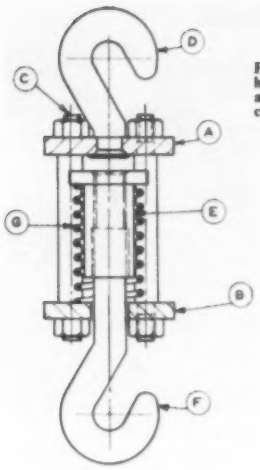
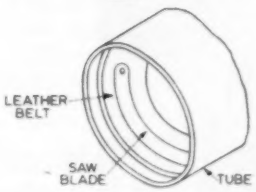


Fig. 2. (left)—Spring 'balance' hooks to this design are easy to make and are very useful for handling components on and off machine tables

Fig. 3. (below)—A length of belt held in place inside the bore of a tube with the aid of a piece of hack saw blade



endeavour to lower the job that extra $\frac{1}{4}$ in. is generally sufficient to overcome the spring load and make such movement easy. Closely wound coils are not desirable.

The hooks are made of circular bar material of some 50 ton tensile strength. Each piece is heated to a very bright red before being pulled round to shape. For this process a long bar is desirable to give leverage using a piece of any steel of the specified diameter to fit the inside of the hook as a gauge. When cool enough to handle, sufficient is cut off to make the necessary fitting diameter and a brief dressing with a file gives a nice appearance.

The practice of tightly filling the bore of a tube with rag to damp out vibration while machining the outside is a familiar practice which does meet with a fair degree of success, but ultra thin tube is always difficult to machine properly and a length standing well away from the chuck jaws will undoubtedly vibrate fiercely unless a more adequate precaution is taken.

A ring of leather belting immediately under the cutting area is effective. The length should be cut accurately so that the ends butt firmly together. A piece of hack saw blade bent to the required curvature and inserted inside the belt will exercise enough force to keep the belt pressed against the inner wall of the tube.

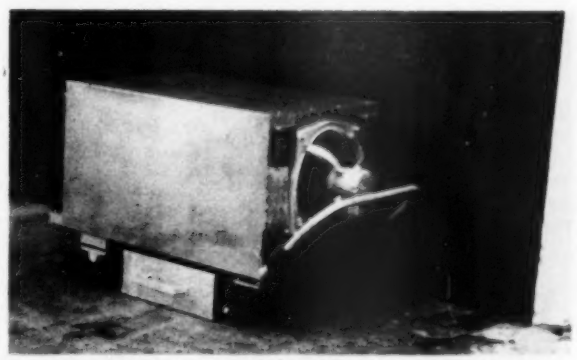
When the bore requires machining pieces of belt are wrapped around the tube and held in place by hose clips.

For driving a tube between centres a rod brazed to a hose clip—the rod long enough to engage with the driving stud on the catch plate—and the clip tightened round the tube provides an effective drive with no possibility of marking the tube if a strip of thick paper is inserted between the clip and the tube.

MAKING PERFORATED SCREENS.—A perforated screen plate during manufacture at the Greenwich works of G. A. Harvey and Co. (London) Limited. The $\frac{1}{4}$ in. thick steel is being 'punched' with 4 in. dia holes which are set at 5 in. staggered pitch. This particular screen will be used for grading coal, but many similar ones are in use in quarries where granite or limestone is crushed. In the quarry industry this type of perforated plate is known as a 'scalper' screen, removing as it does the larger pieces of stone that would otherwise damage the fine woven wire chipping screens

Industrial Dehumidifier

The Trembath industrial dehumidifier is a machine for the extraction of water from the air, operating on the principle of the refrigerator plant, the chief component being the Frigidaire condensing unit. The moisture-laden air is drawn in one end by a fan, forced over the evaporator and cooled to a temperature below its dewpoint. The moisture condenses on the evaporator coils and drains into the portable tank fitted under the machine or runs to waste through hose. The air then passes over the refrigerant condensor causing the temperature of the air to be raised. In the event of the ambient temperature of the air being below 55° F (at which temperature the air does not as readily give up its moisture) six 500 watt thermostatically controlled heater bars come into operation resulting in warm dry air being dispersed and recirculated at the rate of 600 cu ft per minute.



Containing a refrigerator unit, this dehumidifier extracts water from air blown through it by the fan and deposits it in the tray beneath

The dehumidifier will remove up to six gal of water in 24 hr under a design condition of 55° F dry bulb temperature and a relative humidity of 80%.

The unit is mounted on a welded frame of rolled steel angle with solid rubber tyred wheels and swivel castors, and is encased in sheet metal of a wrap-round construction. The fan is protected by a wire screen and switches are inset in the casing. Sole distributors are Greenham Equipments Limited, Ruislip Road, Greenford, Middlesex.

Machine Tool Record

Matrix Hydraulic Broaching Machine

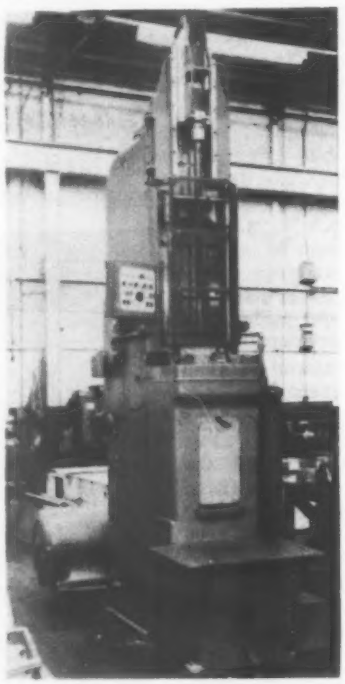
The model TR-15-48 an "American" hydraulic broaching machine built under licence by Coventry Gauge and Tool Company Limited is for use with hand loading and unloading but the design is such that it can be readily converted to a fully automatic machine for the transfer line operation.

The normal capacity of the machine is 15 ton, the maximum length of stroke being 48 in. It is tooled for the broaching of internal cam forms in high speed steel blanks, broaching two components per pass. Using a broaching speed of 4 ft/min, production is at the rate of approximately 90 parts per hour.

The broach is screened by a steel mesh safety gate which affords the operator complete protection, the electrical circuit being so arranged that the machine will not function until this gate is secured.

The machine has an electro-hydraulically controlled semi-automatic cycle. Manual advancement of the retractable table to the broaching position initiates the machine cycle. The ram automatically stops at the end of its downstroke at which stage the operator retracts the table for unloading the broached components and reloading two blanks. Table retraction triggers the circuit for the upstroke of the ram, and when this stroke has been completed and the retriever has carried the broach to its topmost position, the operator advances the table to start the next cycle.

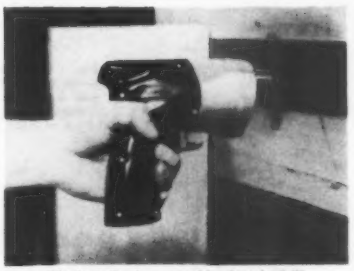
Right. Model TR-15-48 hydraulic broaching machine
Above, blank before and after broaching



Mechanical Pen for Instrument Scales

The prototype of a mechanical pen for the speedy and accurate drawing of instrument scales has been developed by Taylor, Taylor & Hobson Division of Rank Precision Industries Limited, 37-41 Mortimer Street, London W1, to overcome the many problems associated with the conventional method of drawing the scales by hand. It comprises a quill which incorporates a plunger unit, the weight of which is counterbalanced by a coil spring. Each size of pen has its own cartridge, with the correct size of guide hole in the tip. Not more than 0·001 in. error results between any two graduations of scale. The unit is mounted on the engraving machine in place of the cutter spindle and is fed down to the scale face by means of the screw or lever feed. It can be used in two ways: by employing a master copy of the scale face or by picking the calibrated markings previously sketched on the scale face.

Mechanical pen being used on a Model "D" engraving machine



Black & Decker portable electric drill

Battery-driven Drill

A portable electric drill, made by Black & Decker Limited, Harmondsworth, Middlesex, the first of its kind in the world, has a self-contained energy source combining a series of power cells with a highly efficient motor. It completely eliminates the conventional cable and wall plug system.

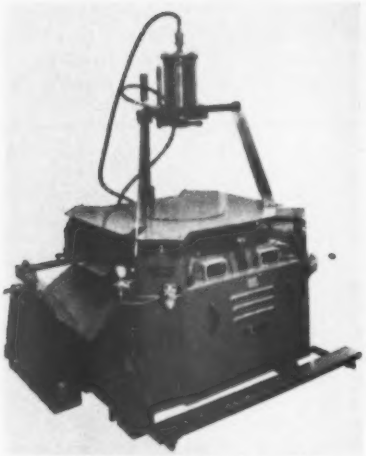
The drill can produce 75 ½ in. holes in ¾ in. wood before it needs re-energizing and can be used also in drilling steel plate. Since the power cells can be recharged 400 times, some 30,000 holes of ½ in. dia can be produced before a new power unit is needed. Thus, allowing for a user drilling some 175 holes a week, the power unit would last for three years without renewal. To recharge the drill is plugged in to any conventional power source for five hours.

The totally enclosed motor is completely protected against dust and dirt. Weight of the unit is only 4 lb, and the cost when marketed in this country will be in the region of £18 to £20.

Trimming Sheet Metal

A machine for trimming drawn metal stampings of irregular shape, made by Moon Brothers Limited of Birkenhead, is built on a cast iron base with legs of the same material. The actual trimming tools, shaped to suit the component, are mounted on four reciprocating slides arranged in two sets of opposite pairs, and running in guideways fitted with adjustable gibs, the entire mechanism being cam controlled. The actual trimming operation takes only a fraction of a second for each component.

In operation, the component is placed over a tool block, the bottom edge of which forms one of the trimming cutting edges. The component is clamped by a pneumatic



Model K.T. irregular trimming machine

chuck whose controls ensure that the operator's hands are out of reach of the trimming tools before they can be actuated. The trimming action is initiated by a treadle which engages a non-repeating key clutch and thus operates the camshaft which in turn engages two pairs of slides in succession, each slide pair being located diametrically opposite the other pair; mutual jamming of the slides is thus impossible. The trimmed component is raised by ejector pads in the tool block to facilitate unloading and the trimmed scrap is cut and removed by the continuously operating scrap cutter and removal hook.

There are two models, the K.T. for sheet up to 12 BG thickness and component diagonals of up to 21½ in. and the J.T. model for sheet up to 24 BG thickness and component diagonals of up to 17 in. Power requirements are 5½ and 4 hp respectively and both are capable of outputs of up to 45—50 parts per minute.

Throatless Nibbling Machine

The special advantage of the Trumpf nibbling machine model TON 300 is that it has no throat and thus the sheet to be worked can be manoeuvred through 360° around the cylindrically shaped tool. The sheets to be cut can be of any size conveniently handled by the operator. Internal nibbling of any shape, simple or complex, can be carried out, and requires only a pre-punched or drilled hole of 18 mm dia. The smallest radius of cut possible is 9 mm.

Trumpf throatless nibbling machine

The cutting line is clearly visible to the operator when nibbling from a tracing. As the hold-down is adjustable in height, a template of metal or wood can be employed, thus ensuring that each blank is an exact replica of the previous one, however complex its shape.

Blanks of any shape or size can be cut from ferrous and non-ferrous sheets up to 3 mm. thick, or from plastics and aluminium sheets up to 6 mm. thick, with a special punch.

The machine has two speeds, 800 and 1200 rpm through a two-step pulley and V-belt. The drive is from a 2 hp motor carried inside the steel fabricated body. Standard electric supply is 400/440 volts, 3 phase, 50 cycles.—F. J. Edwards Limited, 359-361 Euston Road, London NW1.

"Fluid Drive" Up-cutting Shears

An up-cutting shears incorporating their patented "Fluid Drive" principle has been supplied by Joseph Rhodes & Sons Limited, Wakefield, to the Stocksbridge Works of Samuel Fox & Co Limited. Designed specially for inclusion at the end of a 'cut-to-length' automatic line, it is capable of shearing up to a maximum thickness of 1 in. of mild steel or ¾ in. of stainless, to maximum width of 6 ft 6 in. Cutting rate on plate up to ⅜ in. thick is 20 strokes per minute and on thicker plate 6 strokes per minute.

An electro-hydraulic source of power is used to actuate the mechanical action of the shears. There are no clutches, rotating shafts, gears, flywheels; the fluid drive limits the load which can be put upon the machine, and eliminates any ill effects due to accidental overload. The relief valve in the hydraulic circuit ensures saftey against overload. Being of the up-cutting type, the shears allows the line conveyor to be maintained at a fixed height.

Rhodes up-cutting shears with fluid drive

Spring Winding Tool

The hand spring winder made by the Acru Electric Tool Manufacturing Company Limited, Demmings Road, Cheadle, Cheshire, is suitable for making springs in small quantities without the expense of setting up special machinery. The wire is fed through the handle, passing between a steel disc and a plastic disc, which are clamped together, the pressure being varied according to the diameter and hardness of the wire. The wire feeds to a rotating mandrel, the spacing between coils being governed by setting a tapered disc to the spacing required. A new plastic is used for the plastic pressure disc which makes it much easier to control the pressure and to maintain the pressure for longer periods. The winder will accept wire up to $\frac{3}{16}$ in. dia and will form springs of any desired inside dia with a maximum pitch of $\frac{3}{16}$ in. The price of the tool is 65/- including a spare plastic disc.

Acru hand spring winder

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Underwater Camera in Oil Refinery

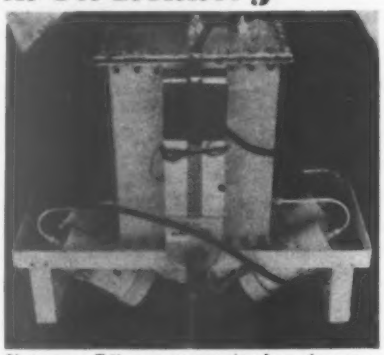
The use of a closed-circuit television camera for direct underwater investigation in an oil refinery has been pioneered by Shell Nederland in their 300,000 b/d oil and chemical plants at Pernis, near Rotterdam. With the manufacturers, they have made a television camera and ancillary apparatus which makes it possible to get a good "picture" of objects lying partly underwater, such as jetties, foundations and sheet pilings. Extensive tests in water 16 m (50 ft) deep have shown that this method gives a very satisfactory picture of the situation underwater.

Up to now this was only partly possible from reports by divers and frogmen. The same type of camera may be used to observe other inaccessible places in the refinery, on land.

The camera and the monitoring apparatus were supplied by the Philips electric and electronic equipment manufacturers at Eindhoven. A watertight metal case was made by the refinery's technical department, to hold the camera clamped in between rubber blocks. To provide enough light for underwater operation, four powerful, independently-operable photographic lamps were fitted next to the lens. To dissipate the heat from these lamps they were packed in copper boxes (sealed to make them watertight). A special polarising filter, which a small motor keeps rotating, was put in front of the lens. This largely eradicates troublesome reflections of light in the water. Eight magnetic rollers were fitted to two frames to facilitate vertical movement of the camera underwater.

At the moment the camera is mainly used to check the condition of welded joints underwater and to see if metal has corroded. The camera enables the welding specialist —or the corrosion expert, as the case may be—to have a direct look at the situation himself instead of having to rely on reports from a diver, who cannot be an expert in every field of technology.

The camera (greatest width 87 cm, greatest length 85 cm—about 3 ft square) is lowered to the place to be examined on cables. It is a very simple matter to connect it up,



Underwater T.V. camera emerging from the water where it is used to examine jetty foundations, welded pipe joints, corrosion damage, etc.

plug into one of the many socket about the site, and the camera is ready for use. As opposed to domestic television, where the picture signal is broadcast, the picture signal from the underwater camera goes by cable. The same cable also contains wires to supply electricity to the lamps and the small filter motor. The receivers have the usual size screens, i.e. 43 or 48 cm (17 in. or 19 in.). An almost unlimited number can be connected up to the camera.

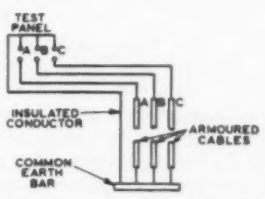
The camera could be used for many jobs. It would be possible, for instance, to locate it high up in a works to get a continuous overall view of the works area from the control-room. Meters, which sometimes have to be installed at great heights, could also easily be read in this way.

Testing Armour Resistance

In order to comply with statutory regulations for electrical installations in mines and quarries it is necessary to carry out periodical tests of the armouring of lengthy cables forming part of the earth-continuity path to ensure that any deterioration of the armour wires will be noticed before it reaches a dangerous condition by presenting an excessively high resistance to the path of any fault current. The normal method of testing the cables involves disconnexion of the supply, the ohmic resistance of the armouring being obtained by the following method.

Any two of the power cores are short-circuited at one end, and the total resistance of the two cores measured from the other end by means of a "Bridge Megger" or "Ducter", the resultant value divided by two giving the resistance of one core. A connexion is then made between one core and the armouring at one end of the cable, and a resistance test at the other end then gives the combined resistance of one core and the armouring in series. By subtracting the previously measured resistance of the power core, the value of the armour resistance is obtained. The drawback to this method, of course, is the shutting down of the whole of the plant fed from such supply cables, and the following alternative method is to be recommended for checking the ohmic resistance of the armouring of a number of lengthy cables, such as may be installed in a pit shaft.

An insulated cable of known resistance should be installed in the same run or shaft as the power cables, and connected at the remote end to a common earth bar. The armouring of each power cable should also be connected to the same earth bar by means of a suitable earthing clamp. At the switch-room or substation end a lead should be brought from each cable armouring to a small panel provided with suitable testing contacts, the insulated conductor being also connected to this panel. The arrangement is shown in the diagram and the testing contacts should be suitably marked for identification purposes. The resistance of any of the cable armourings can thus be measured at any time without interrupting the supply and without the need for a journey to the remote end of the cables on each occasion.



Connexions for testing resistance of cable armour

Valve Flow Test Rig

The basic requirements of any flow test rig are that a known quantity of fluid be passed through the component on test and that suitable means be provided for measuring the static pressure on each side of the component. To obtain steady, accurate readings it is also necessary that the piping upstream and downstream of the item on test (i.e. the test length) be:

(a) of the same diameter as the nominal bore of the component;
(b) extended a minimum of 10 diameters upstream and 20 diameters downstream from the component;
(c) of smooth uninterrupted bore.

To measure the static pressure conditions existing in this special piping on both sides of the test item, pressure tappings of a type which do not cause disturbances of the flow pattern must be fitted in the centre of these sections.

In the new Newman Hender Group flow test rig at Woodchester, Stroud, a Worthington Simpson 3 DM8, 30 hp centrifugal pump (maximum output 200 gal/min at 200 ft head) draws water from a 600 gal reservoir and delivers it, via a 50 ft long 6 in. dia pipe, to the test length and thence back to the reservoir. All tubing used in the test length is BS.1387 medium weight pattern and is pickled and oiled internally to avoid possible disturbance of the flow pattern.

The test length in the rig is 15 ft long and can be isolated by means of two Newman-Milliken round-port plug valves to facilitate changing the test valves and fittings.

Appropriate test length piping, pressure tappings, reducers, couplings and other fittings are available for the testing of all sizes of valves up to 4 in. nominal bore and special arrangements can be made to carry out tests on valves up to 6 in. bore.

Flow measurement is carried out by means of a George Kent P-type orifice plate in conjunction with a 12 in. Kent ST/L single tube mercury manometer, the latter being mounted on the control panel. A range of matched orifice plates is available to measure flow rates up to 400 gal/min. Upstream and downstream from the orifice plate are 20 ft and 8 ft respectively of straight 6 in. dia pipe to ensure accurate readings at the manometer.

To enable the pressure drop across the fitting under test to be registered, $\frac{1}{4}$ in. bore leads are taken from the special pressure tappings previously mentioned to the control panel on which are mounted ranges of Sydney Smith pressure gauges covering all pressures likely to be encountered during testing.

Permanent flow-test rig to provide factual information on valve pressure losses and flow performances to an overall accuracy of ± 2%

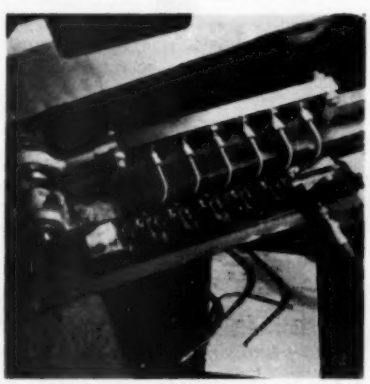
For the measurement of small pressure differences, which might be indiscernible on the gauges, arrangements have been made so that a 30 in. mercury U-tube manometer may be coupled into the pressure gauge system to give differential readings as low as 0·05 psi.

Allowing for the overall accuracy of the instrumentation the test rig enables coefficients to be assessed within an accuracy of ± 2%.

Fatigue Testing Small Bore Tubing

An exacting inspection system plays a vital part in the production of high quality small diameter thin-wall tubing such as is incorporated in large quantities, ranging from $\frac{1}{8}$ in. O.D. to $1\frac{1}{2}$ in. O.D., to De Havillands own specifications in the Trident, the first of Britain's 'second generation' of jet airliners to become airborne. As a result of liaison with De Havillands a fatigue tester for tubing has been specially constructed at Fine Tubes Limited Surbiton mill to simulate and compress into a relatively short period of time the equivalent strains of many thousands of flying hours.

Following rigidly controlled bright annealing and cold drawing cycles down to the specifications required, the tubing is subjected to bore inspection, metallurgical and pressure tests before samples are submitted for fatigue testing. Prior to the test, after sections of small diameter thin-wall tubing have been bent through a right angle, one end is rigidly held in the oil feed manifold whilst the other is connected to a floating coupling. Hydraulic pressure in the region of 6000 psi (well above normal operating limits) is then fed through the tubing and the coupling mechanically vibrated over a throw of 0·015 in. at a variable speed of up to 50 cycles per second. The test is continued over a period of days or weeks to simulate the strains that would be encountered in a period comprising many times the life-span of the aircraft for which the tubing is designed.



Small bore tubes under hydraulic pressure are mechanically vibrated in this machine for fatigue testing

Cooling High-tensile Wire During Drawing

Any increase in the maximum speeds and outputs of machines drawing high-tensile steel wire must be accompanied by a corresponding improvement in the cooling efficiency if the loss in ductility which results from drawing at elevated temperatures is to be avoided.

Experimental tests have shown that improvements in speed of the order of 30% can be gained by preventing the formation of rust deposits on the internal surfaces of the capstans.

Further improvements may be obtained by also incorporating the new "narrow gap" capstan design that has been evolved by the British Iron and Steel Research Association. With this the cooling water is passed through a narrow annular channel between the drawing ring and a stationary inner cylinder. This ensures that the water flow is turbulent which brings about efficient heat transfer. During pilot plant trials it has proved possible to achieve a 40% increase in the production rates of heavy gauge wire with a corresponding increase of 20% for the finer gauges.

This design has the advantage that it can be fitted to most existing machines with relatively little modification.

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UH 64

In Brief . . . .

Notes on New Materials, Plant and Machinery

Rechargeable Battery.—After three years of trials the Etromat rechargeable torch battery, made by Electronics and Automation (London) Limited, London, WC2, is now to be marketed.

Conduit Bender.—Chamberlain Industries, London E10, have a new hydraulic hand bending machine for electrical conduit and similar material up to 1½ in. O.D.

Fork-lift Truck.—The Straddlesack battery-operated fork lift truck has been added to their mechanical handling range by the Montgomerie Reid Engineering Company Limited, Bramley Green, Hants.

Shut Down Valve.—An automatic shut down valve has been designed by I. V. Pressure Controllers Limited, Isleworth, as a necessary safety device wherever high pressure pnuematics or hydraulics are used.

Temperature Control.—An electric automatic control system giving precise regulation of temperatures for industrial and research use is announced by Honeywell Controls Limited, Greenford, Middx.

3-Way Switch Units.—Flexible roller curve units for switching conveyorized items on to spur lines, left, right or straight ahead are being produced by the Manufacturers Equipment Company Limited, Hull.

Overload Slipping Clutch.—A modification to the Metastream overload slipping clutch of Metaducts Limited, Brentford, has increased its capacity by the inclusion of Belleville washers.

Aluminium Reduction Cell.—The British Aluminium Company Limited, London, SW1 and Kaiser Aluminium and Chemical Corporation, California, have jointly developed a modified aluminium reduction cell utilizing refractory hard metals as essential elements.

Gas Chromatograph.—The D6 gas density balance chromatograph made by Griffin and George Limited, Wembley, is the first to incorporate six analytical columns simultaneously.

Fospryme.—Hellman Limited, Crawley, has developed "Fospryme", a new method of phosphating steel either before fabrication or prior to final finish.

Differential Pressure Recorder.—A new type of "Arkon" differential pressure recorder able to measure gas or air differential pressures up to 50 psi or withstand static pressures up to 125 psi has been introduced by Walker Crosweller & Co. Limited, Cheltenham.

Vibroscreen.—The centrifugal separator range of Sharples Centrifuges Limited, Camberley, has been augmented by the Sharples-Kason Vibroscreen vibrating screen separator.

Gas Economiser.—The new 64-2 "Harris" gas economizer for welding torches is marketed by British Industrial Gases Limited, Enfield.

Transdata System.—George Kent Limited, Luton, have introduced a series of solid-state electronic converters, converter-controllers and controllers, some of their first "building blocks" in their range of Transdata equipment for the measurement and control of industrial processes.

Hours Counter.—The Ciberco miniature hours counter of Swiss origin is now available in the United Kingdom through Smiths Industrial Division, Wembley Park Drive, Wembley.

Liquid Filters.—Vokes Limited, Guildford, have introduced a new range of liquid filters under the names "Microwire" and "Microdisc."

Sightglass.—A visual flow indicator, the SSE Sightglass, for use with 99% of all known fluids, is made by Stainless Steel Engineers Limited (Manchester) and marketed by Sir W. H. Bailey & Co. Limited, Manchester.

Vibrex Screens.—G.E.C. (Engineering) Limited, Erith, are manufacturing a wide range of Vibrex two-bearing screens as a counterpart to their four-bearing positive-stroke Gyrex screens.

Rocker Switches.—A new range of "rocker"-operated flush switches has been introduced under the name Classic by J. A. Crabtree & Co. Limited, Walsall.

"Walkie" Truck.—The Vertostacker, a narrow aisle "Walkie" stacking truck is the latest development of Powell and Company, Burry Port, Carmarthenshire.

Magnachute.—Rapid Magnetic Limited, Birmingham, 12, have introduced the Magnachute type F.A., a unit for determining the magnetic content of ores and for checking the efficiency of wet magnetic separators.

Computer System.—The introduction by International Computers and Tabulators Limited, London W1, of the 1500 data producing system, complementary to the 1301 computer, means the company now offers two different computer systems.

Water Hardness Monitor.—The Mark II water hardness monitor is an improved version of the Mark I developed by Nash & Thompson Limited, Tolworth, in conjunction with C.E.G.B. for use in industrial boiler houses.

Centralized Control.—A new plant for the centralized control of batching of liquids used in the manufacture of paint at General and Industrial Paint Company Limited was recently completed by Automatic Control Engineering Limited, London SW6.

Conveyor Belt.—A passenger conveyor belt which eliminates idlers and needs support only at the edges is produced by the Dunlop Rubber Company Limited, London SW1.

Storage Tray.—An addition to the Randalrak storage equipment range made by James H. Randall and Son Limited, London W2, is a 2 in. deep × 18 in. × 9 in. metal tray.

Silver Brazing Alloys.—Welding Improvement Limited, Northampton are marketing five new Fontagen silver brazing alloys, developed for specific needs.

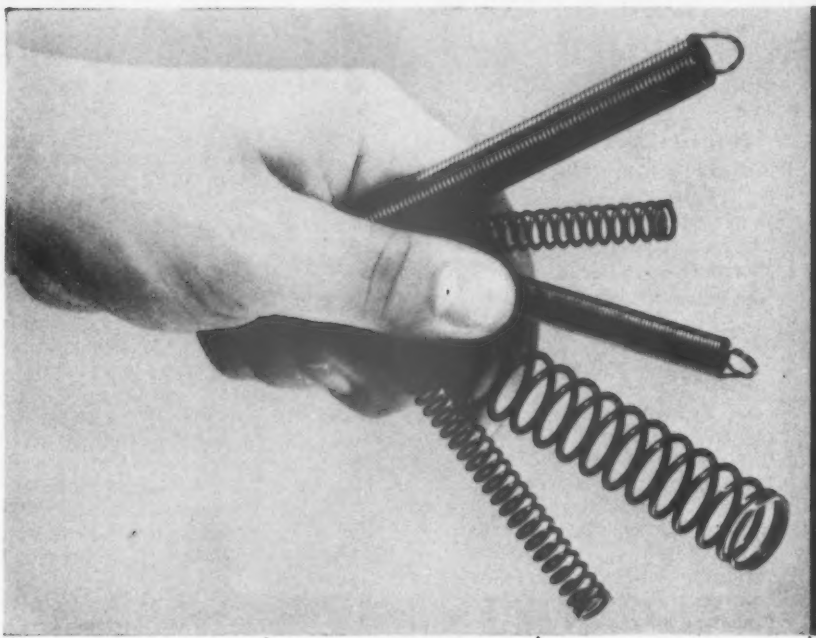
Shotblast Abrasive.—A non-metallic shotblast abrasive "No-Met", is announced by Bradley's (Darlaston) Limited, Darlaston, Staffs., at less than one-fifth the price of conventional metallic abrasive.

Induction Heating.—Vauxhall motors Limited have installed at their Luton works induction heating equipment made by Delapena and Son Limited, Cheltenham, for the heat treatment of gearbox components.

Ultrasonic Equipment.—Tyer & Co. Limited, Guildford, have extended their range of Perram industrial control equipment to include an ultrasonic equipment which uses high-frequency sound above the range of human hearing.

Economical Oil Burner.—A new self-proportioning oil burner for which a 15% reduction in fuel consumption is claimed has been introduced by Premier Oil Burners, Walsall.

Drill Point Grinder.—A new machine made by Z. Brierley Limited, Llandudno, enables twist drills to be ground and backed-off accurately without any skill on the part of the operator.



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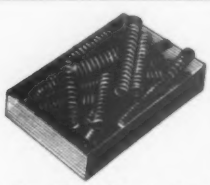
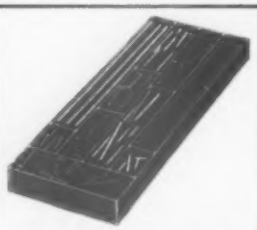


No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., ¼" to ½" diam. **7/6**



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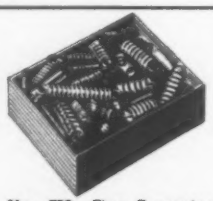

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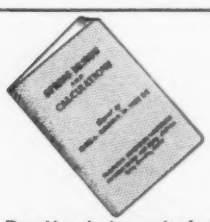

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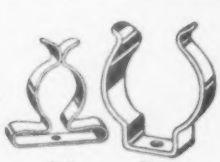

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Arches: Tables for Statical Analyses. By Jan Szymczyk. London, 1961; Pergamon Press Limited. £7 net (by post £7 2 9.) 536 pp. 11½ × 8¼ in.

In many kinds of design there is a set routine for making calculations and designers often adopt a tabular form for setting out their work, finding thereby that a visual check on figures is provided and that there is less chance of error and none of omission.

The next logical step in this idea is to do the main parts of the calculations once and for all so that all that then becomes necessary is to extract the factors and values appropriate to a particular project and apply them to the loading. It is obviously a big job to compute such tables, but that is what has been done for arch design in the book under notice.

With the exception of the first thirty or so pages, the whole book is composed of tables, and they seem to cover much the greater part of everyday practice. The different kinds of loading are provided for and figures are given for some twenty stations along the span, and for sufficiently frequent intervals for all the other variables. Reactions, normal forces and bending moments are given for two-pinned arches (both parabolic and circular) and restraining moments in arches built in at one or both ends. The tables can also be used for arches having movable supports or horizontal ties, and for arches incorporated in more complicated structures. The procedure is fully explained in the first part of the book where the text is in four languages—Polish, English, German and Russian.

Pulsating Combustion: The Collected Works of F. H. Reynst. Edited by M. W. Thring. London, 1961; Pergamon Press Limited £5 net (by post £5 1 6) 310 pp. 6 × 9 in.

Reading this book is an exciting experience. One gets the feeling that combustion technology is on the verge of a major breakthrough which will revolutionize the firing of boilers and the propulsion of aircraft with hitherto undreamed of results.

Francois Henri Reynst, of Dutch nationality, was born in 1909 in Java and died in Paris in 1958. In this book Professor Thring presents Reynst's papers in chronological order, thus showing the gradual development of his ideas. Professor Thring points to eight important new contributions to combustion technology arising from Reynst's work and developed more or less explicitly in his papers. They all start from the Reynst Combustion Pot, a valveless resonator in which combustion is restarted by an eddy. It can be used to supply heat with a very good transfer rate, or pressure with the addition of a resonance tube. Used with a gas turbine it either increases the pressure in the combustion chamber (instead of the drop in pressure which occurs due to friction) or does away with the compressor altogether. Reynst's application of the principle to aircraft propulsion was to accelerate the boundary layer backwards in pulses thus eliminating drag and producing a very high propulsive efficiency. His idea of using oscillatory combustion in large boiler furnaces had the object of removing the need for induced and forced draught fans and to gain a high intensity of combustion and a high heat transfer coefficient.

Reynst did not live to perfect and fully apply his ideas. As Profesor Thring says: "The best memorial to him will be if several of the ideas . . . are in fact brought into complete practical realization . . . "

books

The Technical Illustrator. By Hubert Cook. London, 1961; Chapman & Hall Limited. 35/- net (by post 36/1). 120 pp. 7¾ × 10¼ in.

The basis of technical illustration is the perspective drawing of machinery, but there is a lot more than just this to the accomplished work one sees today, and it is to the acquisition of skill at that high level of execution, layout and presentation that this inspiring and eminently readable book is directed. The work dealt with is the sort of thing one sees in finished form in makers' handbooks and the best catalogues. While a knowledge of perspective is assumed the author nevertheless gives some valuable instruction on practical construction, particularly as regards some of the more awkward details—and this is important, for if these details are not right then the technical value of the drawing is impaired. The chapter on layout is similarly informative—as indeed is the whole book—it will be useful in many engineering drawing offices as well as to specialist illustrators.

Pumping Manual. Morden, Surrey, 1961; Trade & Technical Press Limited. £5 (post free). 662 pp. 7 × 9½ in.

Compiled by the editors of "Pumping" this work aims to provide buyers and users of pumping machinery with the necessary information, technical data, etc., about pumps and ancillary equipment to assist them in purchase, operation and maintenance.

It is in four parts. Part I combines an account of centrifugal and other pumps with a survey of pumping equipment. Part II contains technical data relating to pumping in the form of formulae, tables, nomograms, charts, symbols and a pumping dictionary. The third and fourth parts are made up of a buyers' guide and classified index of trade names, pumping equipment, and components, manufacturers, associations, institutions, etc.

The Milling Machine. By P. S. Houghton. London, 1961; Crosby Lockwood & Sons Limited 20/- net (by post 21/-). 229 pp. 5½ × 8½ in.

The second edition of this work is substantially the same as the first, and the call for a further edition is an indication of the usefulness of the text both in the workshop and classroom. All the details, functions and methods of using the machine are thoroughly dealt with and there are helpful chapters on auxiliary matters such as holding the work, coolants, as well as refined techniques like indexing and gear cutting. There is, too, useful instruction on the estimation of machining time.

Solution of Problems in Fluid Mechanics. By John F. Douglas. London, 1961; Sir Isaac Pitman & Sons Limited. 18/- net (by post 18/10). 226 pp. 5½ × 8½ in.

While it is true that there is no aid to understanding like wresting with

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a problem oneself, the plain fact of the matter is that the young man's time is bounded by the needs of a curriculum or the importance, in the drawing office, of getting something down on paper. There is always a need, therefore, for authentic example, and in fluid mechanics this need is catered for by this book. It covers the notions of fluid statics, and of flow measurement, jets, power transmission, friction, flow under varying load, and uniform flow in open channels. In addition to the worked examples there are further problems for practice together with the answers.

World English.—Probably more people in the world have learnt English as an acquired language than speak it as their mother tongue, states the British Council's Report for 1960-61. Introducing a survey of "The English Language Abroad" the chairman, Lord Bridges, points out that diagnosis and discussion of the form in which help can best be given overseas is one of the most fruitful duties of British Council staff and the teaching of English is a good example of the intensive study and application called for. The report is published by the British Council, 65 Davies Street, London, W1., price 2/6d. net.

Power Equipment Survey.—The fourteenth survey of electric power equipment published by the Organisation for Economic Co-operation and development (obtainable from H.M.S.O., price 10/-) combines the results of two studies carried out concerning equipment used in the electricity supply industry. The information, mainly in tabular form, covers all the member countries of the organisation and will facilitate producers of equipment in the drawing up of their development and production programmes.

Common Market.—A 48-page booklet of this title published by the Information Service of the European Communities, 23 Chesham Street, S.W.1., price 1/-, reviews the reasons for the creation of the European Economic Community, the programme of the Rome Treaty, and the progress made in carrying it out. It describes the institutions of the Community; the steps already taken towards a single market through the reduction of internal tariffs; the first move towards a common external tariff; the gradual abolition of quota restrictions; and associated measures such as provision for the free movement of workers and capital within the Common Market. A further section details the progress made towards common policies in such fields as agriculture, transport, and external trade.

Buyers' Guide.—A new and revised edition of the Northern Region Engineering Buyers Guide has been published by the North-East Engineering Bureau, 18 Ridley Place, Newcastle upon Tyne, price 2/6 post free. Each firm included has a short list of its services and products and there is a classified index. Although marked 1961 it is intended as a 1962 edition and as such provides a valuable and up-to-date source of reference to engineering concerns in the four northern counties.

Journal of Science and Technology.—The first issue of the "G.E.C. Journal of Science and Technology" is a completely restyled "G.E.C. Journal" under a new and more descriptive title. It will be published three times a year—in February, June and October. The first issue contains papers on the airborne digital computer DEXAN, new techniques in power-system design, opacifiers in opal glasses through the ages, the silicon-controlled rectifier and its applications, G.E.C. colour-television receivers and monitors, the diesel-electric vessel 'John Wilson', current designs of large reheat turbines and their development, and an auto-recording photometer and associated lamp-parameter computation.

New Standards

Handbook of Workshop Practice price £3.

The new edition of Handbook No. 2, "Workshop Practice", is an 800-page volume containing a large number of Standards on the subject matter indicated by the title, including some 18 that were not in the previous edition. To be found in it are such fundamental standards as splines and serrations, milling cutters, several screwed fastener standards such as Unified machine screws, Unified hexagon bolts and so on: T-slots, hexagon socket screws and keys, screwing taps for Unified threads, collets, chuck accuracies, jib bushes and the latest edition of the twist drill specification.

Steel roller conveyors (B.S. 2567: 1962) price 4/-

Principal changes in this new edition are an increase in the load-carrying capacity of some types of roller, a tightening of some dimensional specifications, and an increases in the gauge thickness of some of the roller tubes.

Vertical mild steel welded storage tanks, with butt-welded shells, for the petroleum industry. Part 2: Site erection, inspection and testing (B.S. 2654: Part 2: 1961) price 12/6-

Part 2 of this standard, which is designed to provide the petroleum industry with storage tanks (vertical mild steel welded with butt-welded shells) of adequate safety, reasonable economy, and a range of suitable capacities, deals comprehensively with site erection, inspection and testing.

Resistance per unit length of metallic electrical resistance material (B.S. 3466: 1962) price 4/-.

This new standard prescribes the methods to be used in determining resistance in reference and routine tests on metallic electrical resistance material. The reference method provides for an overall accuracy of 0·2% and the routine method for an overall accuracy of one per cent in resistance per unit length on test specimens having a resistance of one milliohm or more. The accuracy of the routine method should prove sufficient for most practical purposes, while the reference method should be used in cases of dispute.

Dimensions of instrument precision roller bearings (B.S. 3469: 1962) Price 5/-.

The characteristics which define instrument precision roller bearings, boundary dimensions and tolerances and internal clearances are specified in this standard, in which the bearings have dimensions and/or characteristics additional to those in B.S. 292 (Dimensions of ball bearings and parallel-roller bearings.)

Endless V-belt drives for industrial purposes (B.S. 1440: 1962) price 10/-.

This revised standard embodies improvements, including a table of dimensions for measuring pulleys, requirements for balancing, and more detailed recommendations for materials; also recommendations for quarter-turn drives, and for power application of V-belts. These are accompanied by tables of horse-power ratings and power correction factors.

British Standards Institution, 2 Park Street, London W1.

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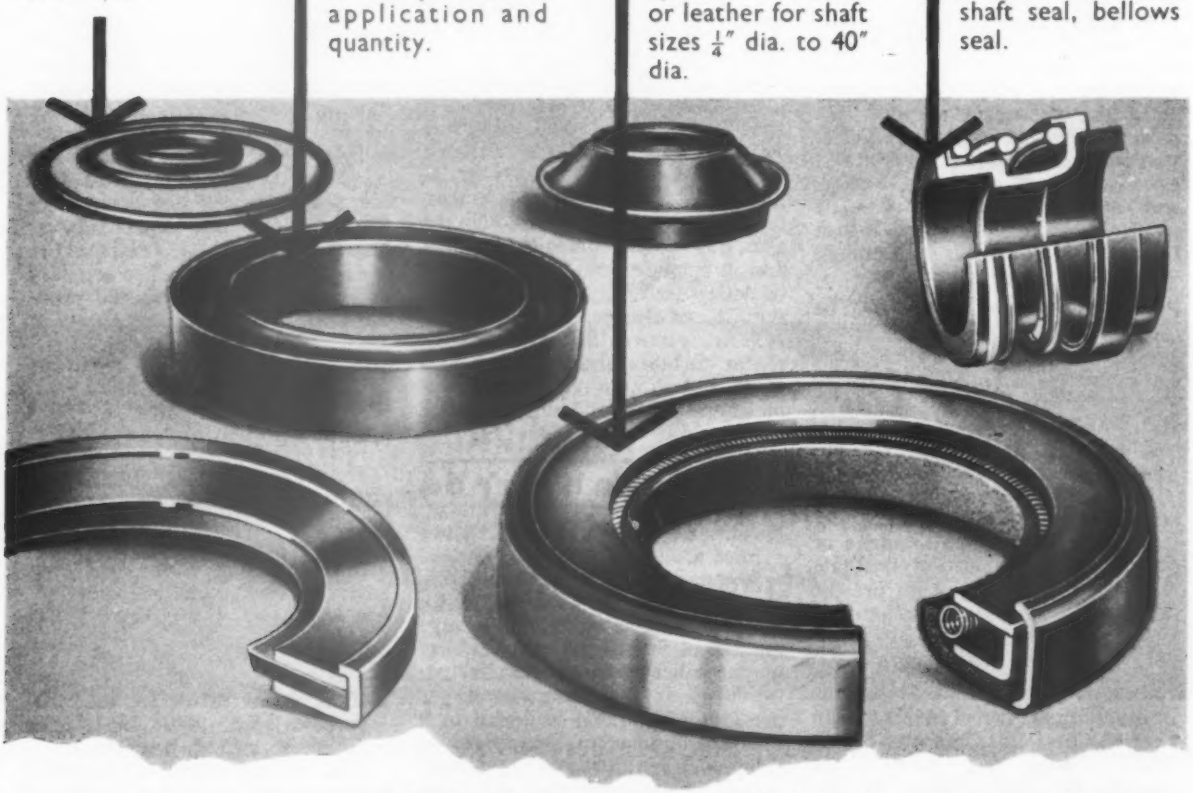

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BUSINESS & PROFESSIONAL

Personal

Mr. Arthur Stowers, B.Sc.(Eng.), M.I.Mech.E., A.M.I.C.E., etc., Keeper of the Department of Mechanical and Civil Engineering Science Museum, retired in January and was succeeded by **Mr. K. R. Gilbert,** the former Deputy Keeper in that Department. **Miss M. K. Weston** is now Deputy Keeper in the Department of Electrical Engineering and Communications.

WESTINGHOUSE BRAKE AND SIGNAL Company Limited, announce that **Mr. H. R. Baines, B.A.,** secretary of the company, has been appointed a director.

ASSOCIATED ELECTRICAL INDUSTRIES Limited announce the following appointments: **Mr. J. E. L. Robinson, B.Sc., M.Sc., M.I.E.E.,** has been appointed division director and general manager of the AEI Transformer Division. He succeeds **Mr. C. P. Holder,** who has taken up other work within AEI. Following the transfer of **Mr. J. D. Riddle** to AEI-Birlec Limited, **Mr. R. Evans, B.Sc.,** has been appointed manager of the Large Machine and Compressor Department, Rugby, AEI Heavy Plant Division. **Mr. D. Scott** has been appointed district engineer of AEI Birmingham Erection Section. **Mr. D. Altman, A.R.T.C. (Salford), A.M.I.E.E., A.M.I.Mech.E.,** has been appointed district engineer of the Cardiff Erection Section. In the industrial control gear organization at the Nelson Works of AEI Motor and Control Gear Division **Mr. T. F. Robertson** has been appointed manager of the works. **Mr. J. M. Fellows, A.M.I.E.E.** has been appointed manager of the Control Gear Engineering Department. **Mr. G. D. Harradine, Assoc. I.E.E.,** has been appointed manager of the Industrial Control Gear Sales at Nelson, in addition to his duties as manager, Industrial Control Gear Sales, Manchester. **Mr. E. F. Seaton** has been appointed assistant manager of Industrial Control Gear Sales, Nelson.

Mr. P. R. Scutt, managing director of Tecalemit Limited and Tecalemit (Engineering) Limited, who will be 65 on May 5 next will be resigning at his own request on July 31, 1962. He will, as from that date, become deputy chairman of Tecalemit Limited and chairman of Tecalemit (Engineering) Limited. **Mr. Nigel J. Bennett, D.F.C., F.C.A.,** will take over as managing director of Tecalemit Limited from August 1, 1962. Mr. Bennett is managing director of British Filters Limited and special overseas representative to the board of directors of Tecalemit Limited.

TURNER BROTHERS ASBESTOS COMPANY Limited, Rochdale, announce the appointment of **Mr. Donald Beech** as assistant manager, Belting Department, with special responsibilities for the sales development and technical promotion of "Poly-V" drives in the United Kingdom.

Mr. K. J. Freeman, M.Eng., A.M.I.Mech.E., has been appointed general manager of Automotive Engineering Limited. He retains his position as director and general manager of Twiflex Couplings Limited. **Mr. G. H. Hogg, M.I.P.E.,** has been appointed to a new post as technical director of Automotive Engineering Limited. The following appointments have been made in Twiflex Couplings Limited.

Mr. J. H. Dawson, A.M.I.Mech.E., commercial manager; **Mr. J. Wright,** chief engineer—Coupling & Damper Division; **Mr. F. Harrison,** chief engineer—Disc Brake Division. Both companies are members of the Sheepbridge Engineering Group.

THE appointment of three new directors to the British Divisions of The Yale & Towne Manufacturing Company is announced. They are **Mr. G. F. H. LeRoy** (works director) and **Mr. A. Langford** (technical director) of the Materials Handling Division, Wednesfield, and **Mr. C. G. Smith** (technical director) of the Lock & Hardware Division, Willenhall.

Mr. L. A. K. Halcomb, chairman of Kayser, Ellison & Co. Limited, retired on December 31 last. Mr. Halcomb, whose maternal grandfather, Mr. C. W. Kayser, senior, was the first managing director of Kayser, Ellison & Co. Limited, had 52 years service with the company.

SANDERSON BROTHERS AND NEWBOULD Limited announce the appointment of **Mr. John G. Westcott** as sales director.

CROFTS (ENGINEERS) LIMITED, power transmission engineers, of Bradford, Yorkshire, announce new appointments at their Leeds and Stoke-on-Trent Offices. **Mr. V. J. Davis** has been appointed to the Leeds office in succession to the late Mr. N. Finch. Mr. Davis was area manager at Crofts Stoke-on-Trent office and is succeeded there by **Mr. R. Briddock,** who has been with the company since 1954.

SUPER OIL SEALS & GASKETS LIMITED, Factory Centre, Birmingham 30, announce the appointment of **Mr. J. Fisher** as technical representative in the South Eastern part of England.

Mr. J. Dowling has been appointed manager and **Mr. D. Lang,** sales manager, of English Electric Liverpool Works.

Mr. J. A. V. Watson, O.B.E., has been appointed a director of Fletcher Miller Limited of Hyde, Ches., a member company of the Castrol Group.

Obituary

WE regret to record the death of **Dr. Ernest Exley Thomson,** of EMI's laboratories of Hayes and Ruislip.

WE regret to record the death of **Mr. Alan Bertram Field,** consulting engineer to Metropolitan-Vickers Electrical Company Limited, from 1920-1943. He was 86. Mr. Field was the first Englishman to receive the L.A.M.M.E. Medal, a very high distinction awarded by the American Institute of Electrical Engineers. From 1914 to 1917 Mr. Field was Professor of Mechanical Engineering at Manchester University.

WE regret to record the death of **Mr. George Arthur Cheetham, A.M.C.T., M.I.E.E.,** managing director of Ferguson, Pailin Limited, from 1942 until his retirement in 1955, and an ex-director of Metropolitan-Vickers Electrical Company Limited and of Edison Swan.

WE regret to record the death of **Mr. D. S. Woodley,** chairman of Keith Blackman Limited. Mr. Woodley occupied a seat on the board for over 24 years.

WE regret to record the death of **Mr. I. T. Watkins,** commercial manager Northern Area (Rectifiers), Westinghouse Brake and Signal Company Limited.

WE regret to record the death of **Mr. William Rushby,** sales director of Moore & Wright (Sheffield) Limited.

Addresses

THE address of the new Liverpool branch of Brown & Tawse Plant Limited is 53-57 Marsh Street, Kirkdale, Liverpool 20. (Tel. Bootle 5417).

SENOL LIMITED have now moved to their new factory and offices at 4, Hardwicks Way, London, SW18.

THE Swansea branch office of Brook Motors Limited is now at Orchard House, Orchard Street, Swansea. (Telephone number SWA 50297).

GEORGE COHEN SONS & CO. LIMITED, Engineer's Tools Department have moved to the company's new machine tool headquarters at 23-25, Sunbeam Road, London NW10.

THE West London office of the Export Credits Guarantee Department has moved to Cunard Building, 15 Regent Street, London SW1 (telephone number Whitehall 9061); and the department's Sheffield office has moved to Fargate House, Fargate, Sheffield (telephone numbers unchanged).

ALL correspondence regarding "Teddington" air gauges should now be sent to Teddington Aircraft Controls Limited,

SAVE wear and you **SAVE** money

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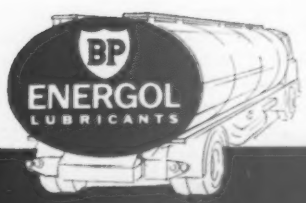
INDUSTRIAL LUBRICANTS



COMPANY LTD.

Cheapside Chambers, Cheapside, Reading, Berkshire. (Telephone: Reading 55235).

STEWARTS and LLOYDS LIMITED, Birmingham office has moved from Broad Street Chambers to Lloyd House, 2 Colmore Circus, Birmingham 4. Telephone: Birmingham Central 3300.

JAMES HALLEY & SONS LIMITED, of West Bromwich, designers and manufacturers of rotary web-fed printing presses and ancillary machinery for the printing industry, now have a London office at 13, Stanhope Gate, Park Lane, London W1, the London headquarters of the Baker Perkins group of companies which James Halley & Sons joined last year.

THE new plastics division of Andrews Bros. (Bristol) Limited is moving to a factory at Prince Alfred Road, Wavertree, Liverpool.

THE FRACTIONAL HORSE POWER MOTOR Division of English Electric is being transferred from Bradford to Liverpool Works.

Contracts and Work in Progress

ROBERTSON THAIN LIMITED.—Contract valued at £400,000 for the cladding of the major buildings of English Steel Corporation Limited for their £26,000,000 Tinsley Park project.

LOEWY ENGINEERING COMPANY LIMITED, Bournemouth, (member of Tube Investments Limited).—Order from France valued at over £100,000 for a 1200 ton oil-hydraulic free-forging press.

BLAW KNOX LIMITED and W. W BROWN & Partners Limited.—Order from Rockware Glass Company Limited of Greenford, Middlesex, for designing and supplying a new glass batch-mixing plant at an approximate cost of £200,000 including civil engineering work involved.

HEENAN & FROUDE LIMITED, Worcester.—Order for four sets of water-cooled Heenan Dynaspede drives placed by Oy E. Sarlin, of Helsinki, acting on behalf of Upo Osakeyhtio of Finland.

PERKINS GROUP.—Order for 500 more British diesel engines for use in Russian Volga cars has been placed by Behermann-Demoen, a well-known Belgian motor firm.

NEWTON, CHAMBERS & CO. LIMITED.—Order for giant walking dragline to be used for stripping overburden from lignite coal deposits in the Province of Potenza, Italy.

W. H. ALLEN SONS & CO. LIMITED, Bedford.—Order for the supply of three Allen-Stoeckicht epicyclic gears from Hawker Siddeley Brush Turbines Limited, a member of Hawker Siddeley Industries, for use on an axial-flow, multi-stage compressor in Tarnow, Poland.

DAVID BROWN INDUSTRIES LIMITED.—Orders worth £80,000 have been received from Denmark and Sweden involving the supply of single- and multi-stage David Brown/Bingham pumps. The orders were placed by the Kellog International Corporation and the Fluor Corporation respectively.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—*Telecommunications Division:* Orders worth more than £75,000 have been placed for the supply and installation of intercommunication equipment at the new Esso Petroleum Company's headquarters being built in Victoria Street, London. Supervisory equipment to indicate a fault condition or irregular functioning of plant is to be supplied and installed for the Dungeness nuclear power station. *Electronic Apparatus Division:* order valued at £22,000 for welder-type ignitrons and over-temperature thermostats from Exico Limited, London, for export to Czechoslovakia. Order for a flue dust monitoring equipment from Electricité de France and another 23 flue dust monitors are for CEGB. *Switchgear Division:* an order worth approximately £1¼ million from C.E.G.B. for switchgear for the Ferrybridge 'C' power station. *Transformer Division:* contract from the Midlands Project Group of C.E.G.B. for two 425-MVA transformers valued at over £400,000. *Construction (Cable and Lines) Division:*. contract to supply 33kV oil filled cables and ancillary equipment worth over £34,000 by the Southern Electricity Board to augment the existing power supply to the Oxford University area. Contract worth more than £66,000 from the Central Electricity Generating Board to augment the existing power supply network in the Kearsley area of Lancashire. Manufacture of the telephone cable has been subcontracted to Telephone Cables Limited (jointly owned by AEI and Enfield Cables Limited), Dagenham. Contract for two further 300-MW steam turbine-generator sets for Lakeview Power Station on the shore of Lake Ontario, near Toronto. The total value of the order, including equipment to be manufactured in Canada, is 9 million dollars.

RICHARD COSTAIN AND ENGLISH ELECTRIC.—A £10 million contract for a dam and hydro-electric power station has been awarded to these two British companies by the Government of the Province of Tucuman, Argentine.

NUCLEAR EQUIPMENT LIMITED, Watford, Herts.—Order worth over £60,000 for five GM 300 mechanical arms to be installed in the nuclear research establishment at Caderache, awarded by the French Atomic Energy Commission.

Business Developments

Trading Agreements

AN agreement has been signed with the Renk Company of Augsburg, Western Germany, for Associated Electrical Industries Limited to manufacture epicyclic gears of the Renk design to operate with AEI turbine and other prime mover driven units such as generators, pumps or compressors.

Company Acquisitions

ONE of the oldest firms in the brewery industry, R. Ramsden & Son Limited, of Leyton, has been taken over by Cope, Allman & Co. Limited, of Bournemouth. Ramsden, who make stainless steel equipment for the industry, was founded in 1741. It is a wholly owned subsidiary of Wade, Smith & Co. Limited, engineers, of Wolverhampton.

LINDUSTRIES LIMITED has purchased the entire equity capital of Joseph Rhodes & Sons Limited of Wakefield for a cash consideration slightly in excess of £1,000,000.

A NEW company, Crittall (Malaya) Limited, has been formed to manufacture Crittall standard metal windows in Malaya. The new factory located in Petaling Jaya, in addition to manufacturing standard metal windows will assemble purpose-made aluminium windows and curtain walling made in Britain.

A holding company, B. & S. Massey & Sons Limited has been formed to control the manufacturing activities of B. & S. Massey Limited and its previous subsidiaries Joseph Berry Limited and Grosvenor Steel Fabrications Limited.

A limited company has been formed under the name of George Cooper (Sheffield) Limited, to take over the manufacture of nuts, bolts and fastenings of all kinds carried on by Thos. W. Ward Limited under the trade name of George Cooper & Sons.

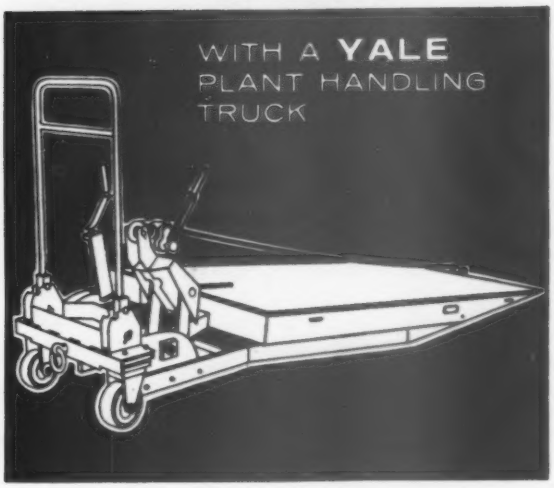
Long Service Awards

GIFTS of their own choosing to four of the operating staff of Metalock (Britain) Limited were recently awarded at a long-service presentation ceremony by the firm's managing director, Major E. Peckham. The men qualifying for the awards with 10 years' service were Messrs. W. Day, M. D. Gomez, J. F. Hamilton and V. D. Palmer. In addition the company presented cheques for the men's wives.

Westinghouse Training Course

ANOTHER pre-G.C.E. examination course for sixth form boys giving them a first-hand insight into the engineering industry is to be held by Westinghouse Brake and Signal Company Limited at their Chippenham works next month. Applications were requested from boys who will be taking the examination in 1963, by the first of March.

cut your machinery handling time



One man and a Yale plant handling truck can shift machinery weighing up to 5 tons in a fraction of the time taken by more conventional methods.

This specialised truck has a tilting platform which can be angled until flush with the floor. The load is then drawn on to the platform by the Pul-Lift fitted at the front of the truck. When the load is secured (the platform is pierced with holes and fitted with strong rings) the truck is ready to move off.

The Pul-Lift is detachable and can be used for all kinds of other pulling and lifting jobs. Yale Plant Handling Trucks come in capacities of 2, 3 and 5 tons.

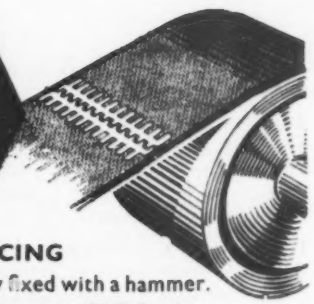
THE YALE ADVISORY SERVICE *will gladly give you free advice on any aspects of materials handling. A Free booklet giving information about Yale trucks and hoists will be sent with pleasure.*

YALE

The world's largest range of materials handling equipment

THE YALE & TOWNE MANUFACTURING COMPANY
BRITISH MATERIALS HANDLING DIVISION DEPT. MW2
WEDNESFIELD STAFFORDSHIRE

BAT BRAND MADE IN ENGLAND



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A reliable safe joint easily fixed with a hammer.

All types of machinery belting can use 'BAT' Flexible Belt Lacing for joints of exceptional strength and flexibility held by the newly designed double rocker pins.

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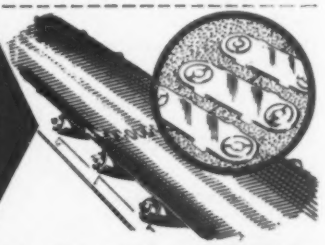

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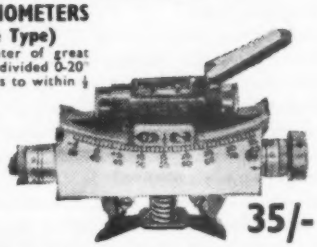
(Micrometer Bubble Type)

An Engineer's Clinometer of great precision. Main scale is divided 0-20° in 1° divisions and angles to within ¼ minute can be read speedily on the micrometer thimble. For their original military purpose a clip was fitted to the base but but this clip can be easily removed in the Machine Shop. Nett weight 22 ozs. Length of base 3¾ in.



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OPTICAL EXPERIMENTAL SET in Transparent Pack. Type A contains 30 graded lenses. Type B contains 30 selected lenses, prisms and polaroids. Either type, per set. **42/-**

The NEW RUSSIAN MICROSCOPE as shown at the Soviet Trade Fair. **£47.10.0**

GL 516 16 m.m. SOUND PROJECTORS —perfect **£59.10.0**

EX-R.A.F. ADJUSTABLE BENCH LAMPS **33/6**

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TRACING PAPER—EX-GOVT., 33 yds. × 20 in. Perfect. Per roll, including post. **21/-**

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Britain's greatest stocks of new, used and Ex-Government Optical and Scientific Equipment. Send for Illustrated Catalogue.

Semiconductor Devices

Electronic apparatus division of Associated Electrical Industries Limited, has issued an application report on semiconductor devices which outlines several simple firing circuits for the AEI 4-amp, 5-amp. 8-amp and 10-amp series of controlled rectifiers when used in series and parallel inverters, and half-wave or full-wave phase control circuits. Copies of the publication (No. 4450-202) may be obtained from AEI Electronic Apparatus Division, Valve & Semiconductor Sales, Carholme Road, Lincoln.

Distillation Plants

A number of brochures setting out the various applications of Aquaflesh distillation plants have been issued by the makers, Buckley & Taylor Limited, Castle Iron Works, Oldham. These are "Distillation Plants for Land Installation"; Distillation Plants for Marine Installation; and" "Electric Distillation Plant". Another brochure from the same company deals with heat exchangers and condensers.

Unit Conveyor System

Over the past few years a market has developed for a belt conveyor system the units in which—available from stock—can readily be assembled to fit the customer's plans. With this in mind, Bagshawe & Co. Limited, Dunstable Works Dunstable, Beds., have developed the "Beeline" system which is an illustrated catalogue setting out the design features.

Cooling Coils

A new 8-page illustrated booklet (No. B-1818) describing cooling coils for air conditioning, process cooling and general cooling application is available from American-Standard Industrial Division, Detroit 32, Michigan. It contains illustrations and discussions of cleanable chilled water coils, standard chilled water coils, and direct expansion coils.

Stainless Steel for Buildings

Samuel Fox & Co. Limited, Stockbridge, Works, Sheffield, one of the branches of the United Steel Companies Limited, manufacture stainless steels in about sixty different qualities. The company have issued a 40-page booklet, "Stainless Steel in Architectural Design" in which is offered to architects and others concerned with the art and science of building technical information about the properties, performance and availability of stainless steel in building applications.

Terylene Conveyor Belting

"Convey it with Terylene" is a new booklet produced by the fibres division of Imperial Chemical Industries, Hookstone Road, Harrogate. Various current uses of Terylene are described and illustrated and some probable developments are outlined.

Oscilloscope: Position Control

A wide-band oscilloscope with a range of plug-in pre-amplifiers providing differential, high gain and dual trace input facilities as well as the normal 40 Mc/s wide-band input—the EMI Oscilloscope Type WM16—is described in a new leaflet recently issued by EMI Electronics Limited, Hayes, Middlesex. Another leaflet from the same company describes the latest addition to their series of machine tool position control systems, the EMICON B100. Employing the well proven analogue system of measurement, this has a positional accuracy of $\pm$ 0·002 in.

Furnaces

Two new illustrated leaflets from The Incandescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham, describe direct and indirect fired roller hearth furnaces and radiant jet furnaces.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Refractories for Bagarse-fired Boilers.

Bagarse, the waste product from sugar cane, is an inexpensive fuel but it requires special furnaces when used for steam raising, and also special refractories such as those described in a new brochure from General Refractories Limited, Genefax House, Sheffield 10.

Laboratory Furniture

A complete unit system of laboratory furniture (both metal and wood) is fully described and illustrated in a new catalogue available on request from Griffin & George Limited, High Street, Cowley, Uxbridge, Middlesex.

Hydraulic Cylinders

The first two products in a new range of hydraulic equipment are fully described in Bulletins 100 and 101 from E. Mathews Engineering Company Limited, 67 Jeddo Road, London W12. They are a range of dual-bore cylinder units and a range of ICM line cylinders both for oil hydraulic equipment in the 1000—10,000 psi range.

Spark Machining

Johnson, Matthey & Co. Limited, 73-83 Hatton Garden, London EC1, have issued a new publication on their spark machining electrode material, Elkonite 10W3.

Industrial Controls

The latest list from Baldwin Instrument Company Limited, Dartford, Kent, gives brief descriptions of the instruments and fluid power equipment made by the company.

PTFE Flexible Pipes

Flexible pipe assemblies which meet a wide range of applications are described and illustrated in a new brochure from Henry Crossley (Packings) Limited Hill Mill, Astley Bridge, Bolton, Lancs.

Plywood for Building

A brochure from the Plywood manufacturers Association of British Columbia, 1 Grosvenor Square, London W1, describes briefly some of the advantages in using strong, lightweight fir plywood for making sub-floors.

Programme Card Controllers

Information sheets from Engel & Gibbs Limited, Elstree Way, Borham Wood, Herts, describe a number of applications of programme card controllers to machinery and plant of various kinds.

Ventilators

Examples of a selection of roof ventilators installed on industrial, commercial and public buildings are described and illustrated in a leaflet from Greenwood's and Airvac Ventilating Company Limited, Beacon House, Kingsway, London WC2.

Hardfacing

Three grades of Delcar hardfacing rod, which contains particles of tungsten carbide, are fully described in a new publication from Deloro Stellite Limited, Stratton St. Margaret, Swindon, Wilts.

Catalogues Received

Spacesaver storage containers, shelf units and accessories. Bradley & Co. Limited, Albion Works, Bilston, Staffs.

Ranplan drawing storage steel cabinets. James H. Randall & Son Limited, Paddington Green Works, London W2.

Trepan shearer. BJD Anderton Shearer-Loader. British Jeffrey-Diamond Limited, Stennard Works, Wakefield,

The uses of Stellite alloys. Deloro Stellite Limited, Stratton St. Margaret, Swindon.

Recirculating ovens G. & R. Gilbert (Industrial) Limited, Hackbridge Road, Hackbridge, Surrey.

Silver brazing of stainless steel. Johnson, Matthey & Co. Limited, 73—83 Hatton Garden, London, EC1.

Wayne Kerr—Gertsch complex ratio bridges. Wayne Kerr Laboratories, 44 Coombe Road, New Malden, Surrey.

Kiene hydraulic test pump. Lemag engine indicators and vibration measuring instruments. Kiene diesel pressure indicator. International Engineering Concessionaires Limited, 39 Parliament Street, London SW1.

Philplug bolt chart. Expandite Limited, Chase Road, London NW10.

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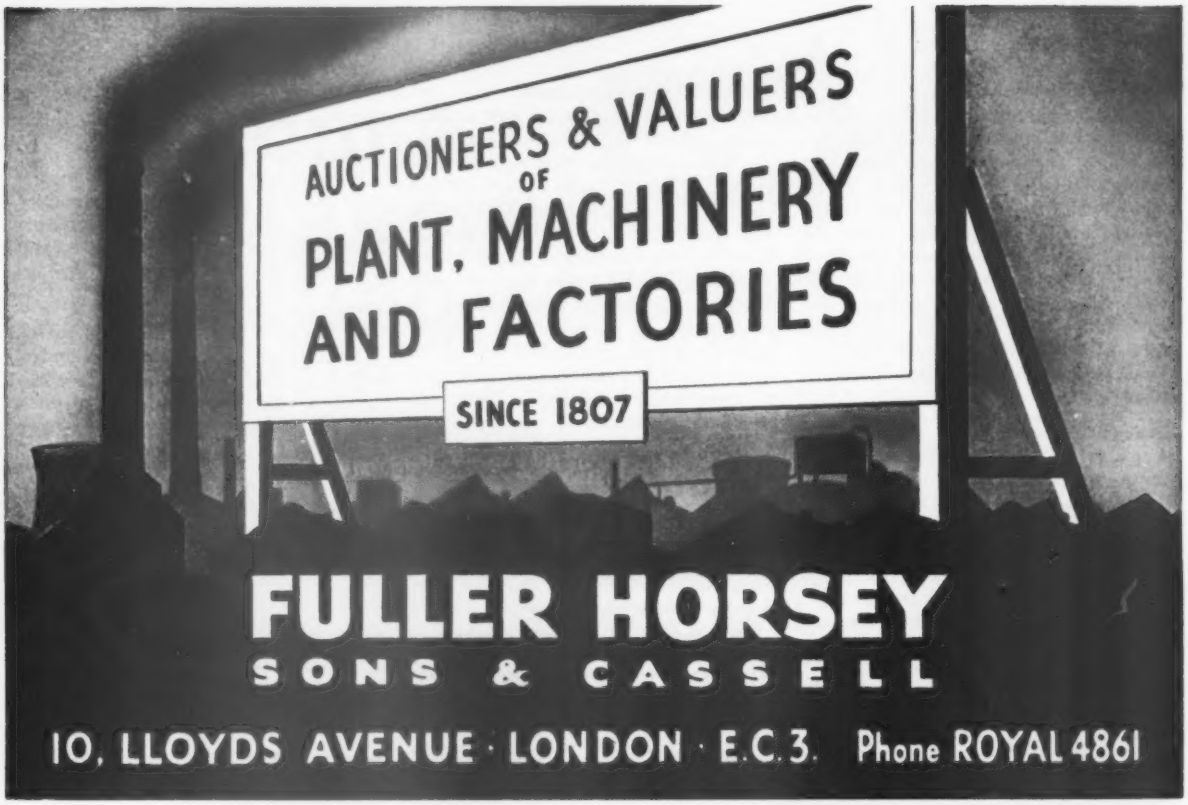

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Mill roller bearings The Mirlees Watson Company Limited, 45 Scotland Street, Glasgow.

Industrial and office steel storage equipment. W. H. Dixon, Broseley Hall, Broseley, Shropshire.

Portable welding screens and fireproof and flame resistant curtains. George W. King Limited, Stevenage, Herts.

Alston (Cumberland). Precision Products (Cumberland) Limited. The contractors for factory extensions are Kearton and Son, Market Place, Alston.

Ashington. Culpitts and Son, Limited. The factory on the Jubilee Estate is to be extended by the Industrial Estates Management Corporation, Team Valley Estate, Gateshead.

Berwick. Irvine Electrical Services, Limited, Newcastle-on-Tyne are to erect a distribution and servicing depot at Castlegate. The architects are Doffman and Leach, 17 Wolverhampton Road, Stafford.

Bishop Auckland. Swales Estate, Limited. The architects for proposed light industrial buildings at South Church Road, are M. C. Robson and Son, Station Chambers, Newgate Street.

Brandon (Co. Durham). J. Burdon and Son, Ryhope Dene, Ryhope, near Sunderland. Garage, workshops and offices are planned on the Littleburn Industrial Estate.

Gateshead. Smith Rodley and Company. Factory additions are proposed at Team Valley. The builders are Bewley and Scott, Limited, Dunston-on-Tyne, and the architects, Arthur and Kirkup, 13 Swinburne Street, Gateshead.

Hexham. Airscrew Company and Jicwood Limited, Weybridge, Surrey, are to erect a factory at Hexham for the making of chipboard. Work on the scheme is expected to start in the spring.

Airscrew-Weyroc, Limited, Weybridge. The R.D.C. has approved outline plans for a new 160,000 sq. ft. factory.

Longbenton (Northumberland). Thomas Hedley & Co. Limited, City Road, Newcastle-on-Tyne are to extend their research laboratories at Whitley Road, Longbenton. The firm have their own architect. No contracts let.

Newcastle-on-Tyne. R. B. Charlton and Co. brassfounder. Plans have been approved for factory alterations on White Street, and Mitchell Street, Walker.

Sedgefield. Ferryhill Manufacturing Company Limited, Plans have been prepared for the erection of a factory and offices at Dean Bank. It is understood that the buildings will cover about 20,000 sq. ft. The architect is Bernard Kruger, A.R.I.B. 13 Cork Street, London, N.W.1.

Silloth (Cumberland). Carr's Flour Mills, Limited, are to extend their plant at Silloth.

Sunderland. J. A. Jobling & Co. Limited, Wear Glassworks, Pallion. Factory additions (27,000 sq. ft.). The architects are Matkin and Hawkins, Barclays Bank Chambers, Fawcett Street, Sunderland, and the contractors are R. E. Coleman, Limited High Street, Carrville, Durham.

Whitehaven. Marchon Products, Limited, chemical manufacturers, Whitehaven are to spend £140,000 improving facilities for unloading phosphate rock at Queen's Dock, Whitehaven. The work will include constructing two silos each 100 ft. high with a total capcity of 6,400 tons with an overhead conveyor belt system.

Birmingham. Brindley Limited, 47 Vincent Parade, Birmingham 12, are to erect a new factory.

Parry & Sons. (Overmantel) Limited, Globe Works, Upper Highgate Street. A new factory is to be erected in Charles Henry Street.

Blackpool. T. Mellor, Old Market Hall, Lytham St. Annes. A new engineering workshop is to be built at Sutherland Road West.

Bootle. Skinner & Richards Limited, are to extend their works in Waddicar Lane, Melling.

Bournemouth. Saunders Patent Carding Machine Works Limited, in Wallisdown Road. The factory is to be extended.

Bracknell. Corrugated Products Limited, are to extend their factory at Western Road. The architects are Cooper Brocklehurst & Williamson, 39 High Street, High Wycombe.

Brough Clothiers are to extend their factory at Western Road.

Bristol. Poeton Industrial Plating Company Limited, Whitehorse Street. Extension to factory.

Castlereagh. Sir Isaac Pitman & Sons. The Northern Ireland Ministry of Commerce are to extend the factory.

Cheltenham. Spirax Sarco Limited. The works at Redesdale Lawn, The Park, is to be extended.

New Factories

Coventry. Carter Stevens Automation Limited, Fletchamstead Highway are to build a new factory in Torrington Avenue.

Croydon. C. J. Neuman Ltd, Brighton Road are to erect a new factory.

Sinu Limited, Old Brewery, Church Road are to build a new factory.

Dagenham. H. Powe Limited. The factory in Wantz Road is to be extended.

Dartford. Webb Conveyors & Automation Limited, Princes Road. Extensions to works.

Eastbourne. Bonded Bearings Limited, have submitted plans for a new factory on the Brampton Road trading Estate.

Enfield. R. S. Lloyd Limited, 2c Balham Road, London. N9. A new factory is to be built at Duck Lees Lane.

Belling & Co. Limited, are to extend their works at Bridge Works, Southbury Road.

Glasgow. Monks & Crane Limited. A new factory is to be built at Dixon's Blazes, Lawmoor Street.

Midland Electric Manufacturing Company Limited, are to erect a new factory.

Hull. Spooners (Hull) Limited, Glebe Road, Stoneferry are to erect a new factory.

Leicester. D. Byford & Co. Limited, Abbey Lane, are considering the erection of a new factory at Immingham.

Liverpool. Amalgamated Dental Engineering Industries Limited, Mount Pleasant are to make extensions to their works.

Lytham St. Annes. Extensions are to be made to the factory at Preston Road for the Dudley Hill Engineering Company Limited.

Macclesfield. Kay Bros Plastics Limited. Marple are to build a new factory on the Hurdsfield industrial estate.

Margate. Permission has been received to erect extensions to the factory of Rover Scale Models Limited, Westwood industrial estate.

Newry. Co. Down. Northern Waterproof Company Limited, are to have a new factory built.

Oldham. Pasolds Limited, are to make large extensions to their Belgrave Mill.

Paisley. Seedhill Finishing Company. Seedhill propose to erect a new factory.

Perth. Plans have been approved for the erection of a new factory at Friarton for Liquid Fertilizers Limited, Grange Road, Batley.

Portsmouth. Extensions are to be made to No. 2 factory for Fireproof Tanks Limited.

The factory of Bell Punch Company Limited, Rodney Road, Fratton is to be extended.

Redditch. A new factory is to be built in Arthur Street for Midland Wire Cordage Company.

British Aluminium Company Limited, are to extend their factory at Studley Road.

Rishton. Extensions are to be made to the works of Broadloom Carpets Limited, Wheatfield Mills.

Sandwich. Petbow Limited, has received permission to make extensions to their factory.

Sheffield. Albert Marsh & Co. Limited, Solly Street. Land in Dolly Walk and Brownwell Street is to be used for the erection of a new factory.

Smethwick. Halford Polishing & Plating Company Limited, Ford Street, Birmingham. 41. A new factory is to be built in Oldbury Road.

Slough. Slough Estates Limited, are to erect a new factory in Buckingham Avenue.

Wellingborough. Tresco Plastics Limited. Plans have been approved for extensions to the factory at High Street, Earls Barton.

West Bromwich. Barton & Sons. (Netherton) Limited, Atlas Works, Netherton. A new factory is to be built at Bagnall Street.

West Drayton. Durapipe & Fittings Limited, Winnock Road, West Drayton are to extend their factory.

Winsford. Sir James Farmer Norton & Co. Limited, Adelphi Street, Manchester, 3. Proposed new factory.

York. Bootham Engineers Limited. Permission has been received for extensions to works at Bootham Row.

Airdrie. Airdrie Electronics Limited is to start a major expansion programme including the construction of a big machine shop employing over 100 men, equipped with a full range of manufacturing plant.

Bishopton. Clyde Navigation Trust are to build an oil terminal at Longhaugh near Bishopton, on the Clyde. Rendel, Palmer and Trotton of London have been appointed consultants.

Cockenzie. The South of Scotland Electricity Board is to build a £50 million power station at Cockenzie, East Lothian.

Dumbarton. Strathleven Bonded Warehouses Limited have received building permission for a major bond store at Gooseholm, Dumbarton, employing 250. The architect is Mr. J. N. Cunningham, Glasgow.

Dundee. Lintafoam Industries Limited are asking for B.O.T. support for a 50,000 sq. ft. factory.

Lurgan (Co. Armagh). A factory is to be built at Lurgan for the manufacture of micronic cloth, an invention of the Pall Corporation of New York. The cloth, made of tightly woven very fine stainless steel wire, is used for high precision filters, etc.

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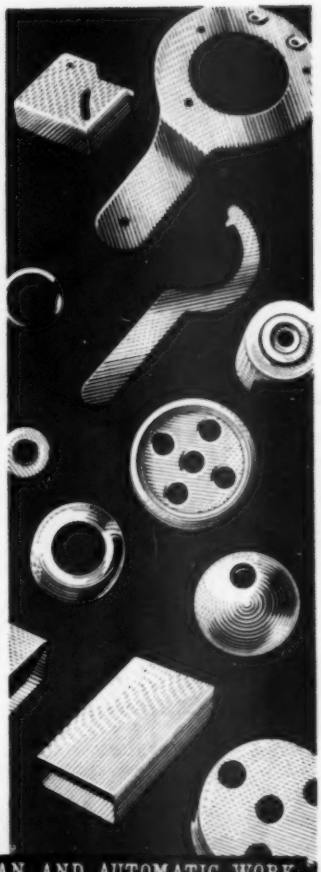

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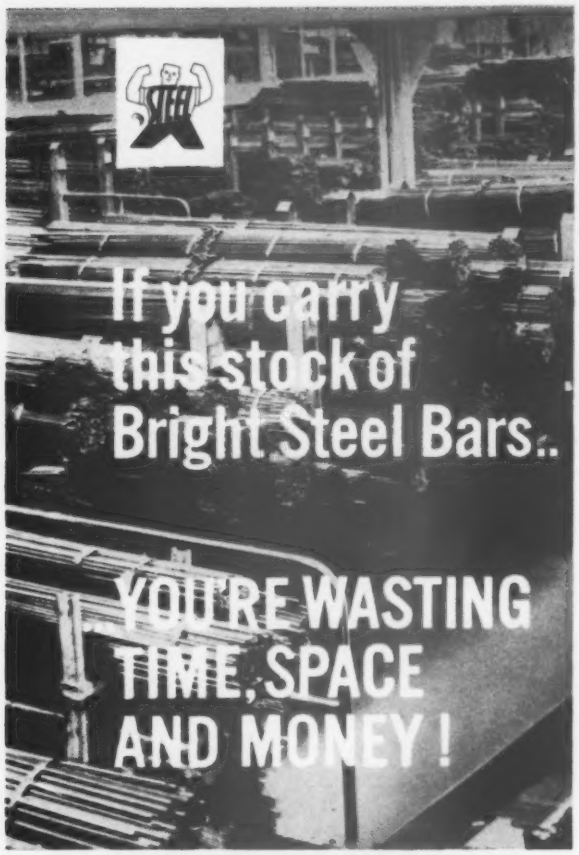

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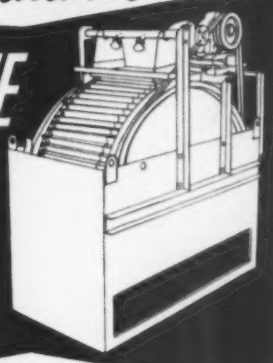

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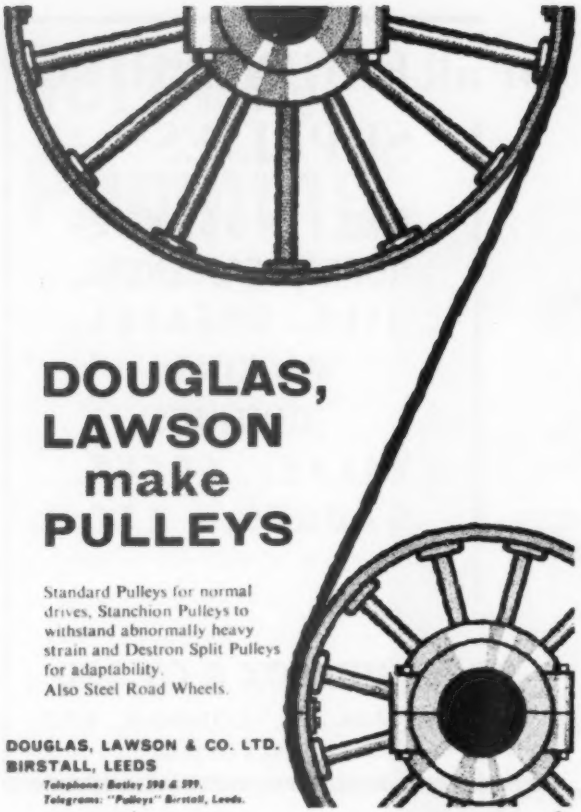

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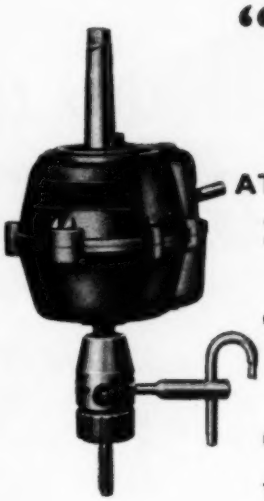

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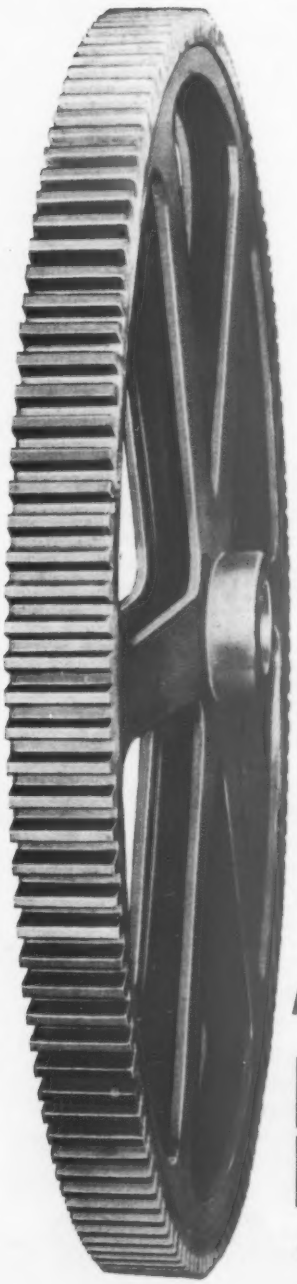

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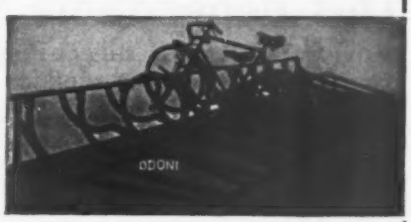

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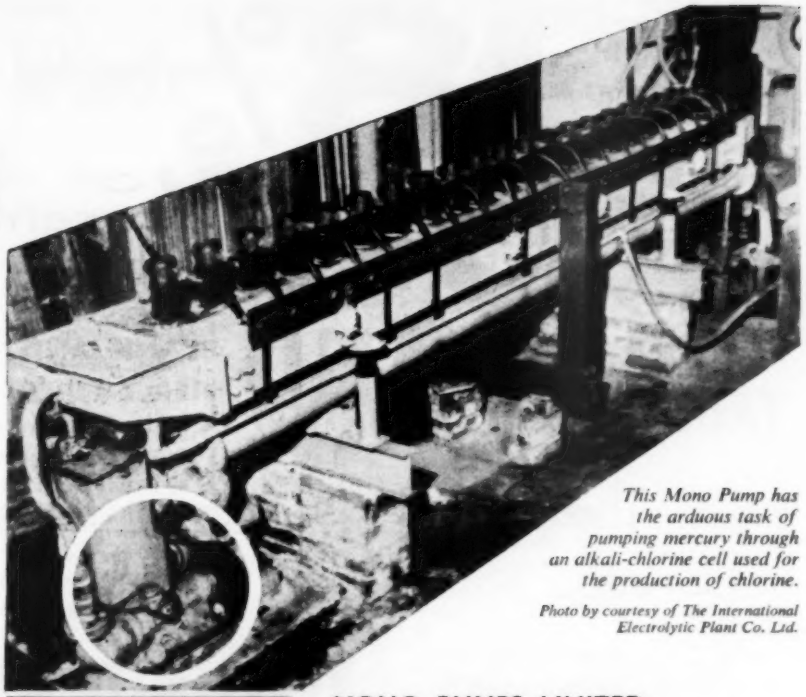

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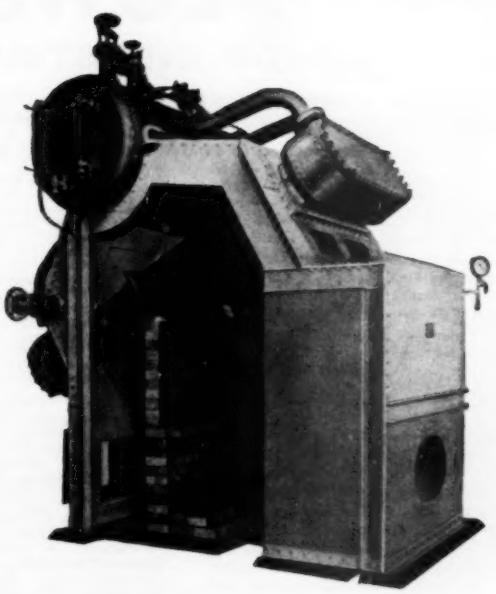

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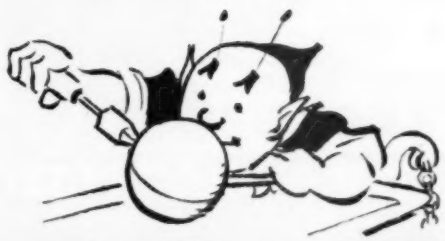

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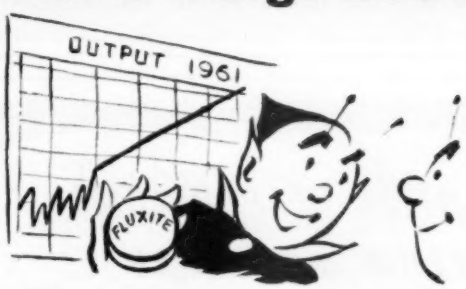

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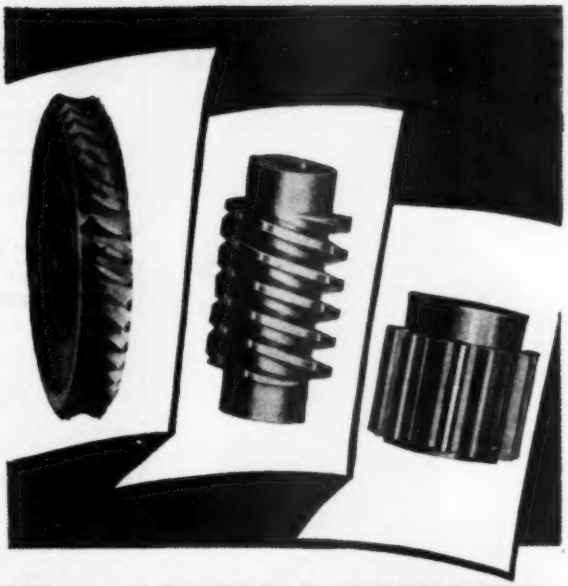

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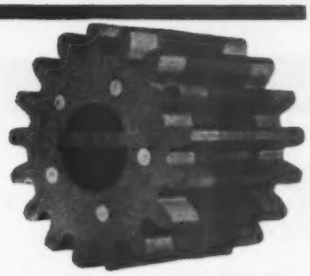

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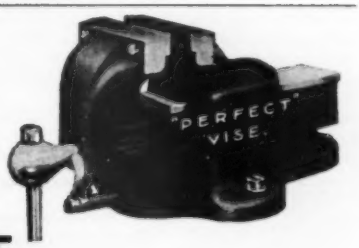

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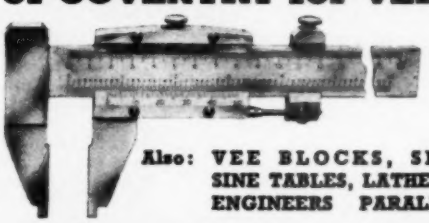

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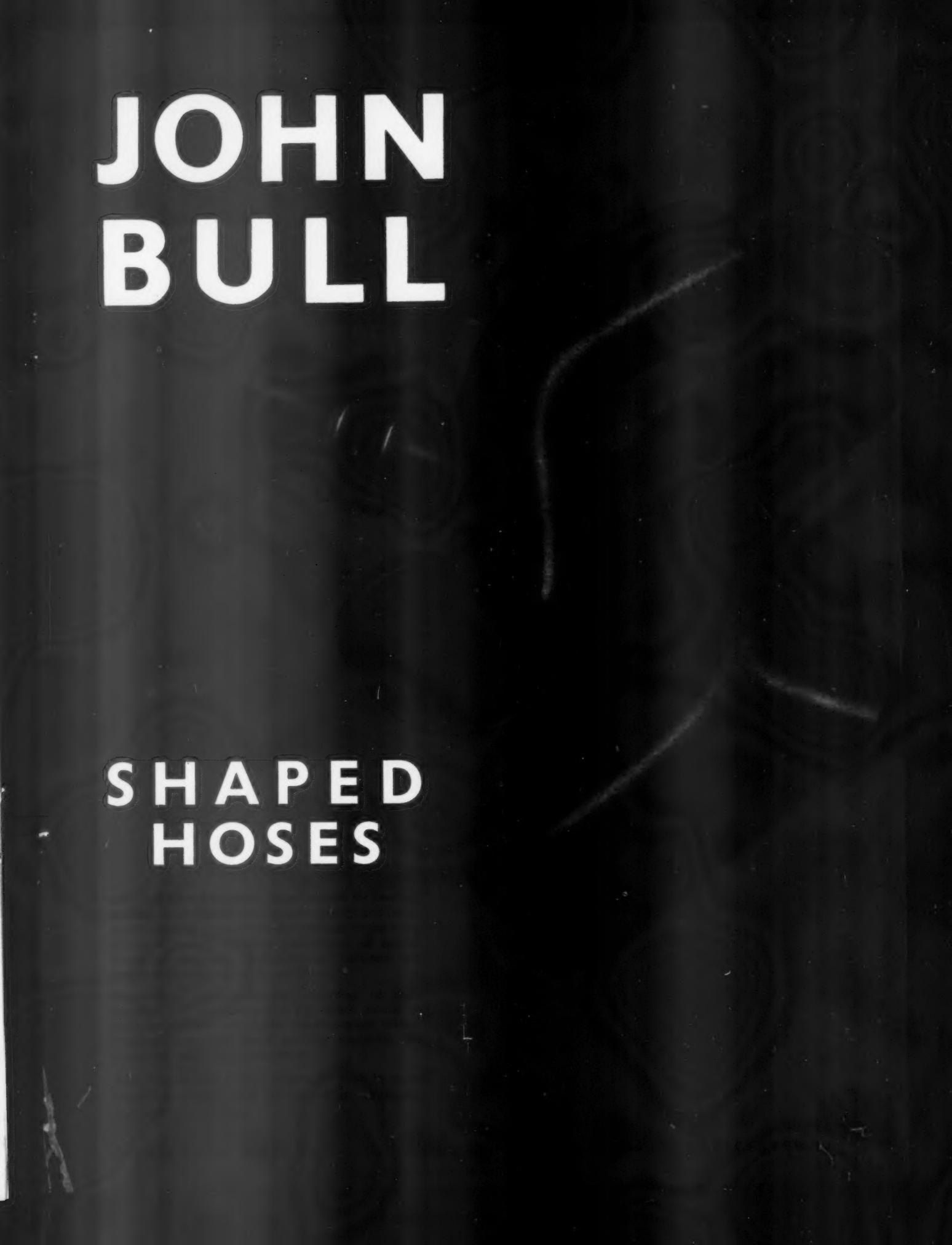
(1) FOLD DOWNWARDS ALONG THIS LINE

JOHN BULL

SHAPED HOSES



BAUER

From 1/50 to 30 HP
totally-enclosed fan-cooled
for the drive of slow-speed
machinery and equipment of all kinds